MODERN Developing METHODS

for

PRINTS AND FINE GRAIN NEGATIVES

Third Edition
Revised and Enlarged

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Compiled by the technical staff
of The Edwal Laboratories, Inc. under the
direction of Edmund W. Lowe, Ph.D.

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. . . . "LET the reader make the effort and consider seriously what he would give at any moment to have the power of arresting the fairest scenes, those which arise before him only to vanish; to stay the cloud in its fading; the leaf in its trembling, and the shadows in their changing; to bid the fitful foam be fixed upon the river, and the ripples be everlasting upon the lake . . . "

*Ruskin**

. . . Yes, and add to Ruskin's "fairest scenes" our children in their laughter, our men in work and battle, our women in their beauty!

To record the glory of today for enjoyment on the morrow, and to make that record compelling and fine; these are the objectives of the serious photographer—for whose aid this book is written.

* Ruskin was not writing *for* photography when he composed the above word-gem. It is a part of an essay in which he condemned the "feeble sunstain" variety of his day. But no man has ever phrased more eloquently the power that photographers wield with today's techniques — and Ruskin would agree if he could see today's results.

THE PURPOSE of this book is to give a simple explanation of the practical details of developing, fixing, and other chemical processes used in making prints and fine grain negatives. It is not necessary to be an expert in either chemistry or photography to understand and use this volume. We have, however, collected and included information which we hope will be of value to even the most advanced photographers.

Since there are occasional changes in photographic emulsions and other materials, new questions may come up which are not covered in this edition. In such a case, the reader is cordially invited to write directly to the Edwal Laboratories for information on any photographic subject. Wherever possible, we will search out and send you such information as we can find. Sometimes, such information is of general interest and we add the subject to those covered in our laboratory data sheets which are short discussions of individual photographic subjects.

Camera Clubs are invited to write for material to be used in programs and lectures. We are preparing a series of lectures which can be presented to a camera club by any interested amateur when it is not possible for one of our staff to take part in your club program. We strongly urge photographic amateurs to take advantage of the many helps in dark-room work provided by membership in an active camera club.

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"Mine" *Rowena Fruth*

Print developed in Edwal-102.

Edwal-102 is supreme among print developers for recording delicate gradations of tone. That is why it is recommended for portraits of children and high key subjects.

Chapter I

PRACTICAL NEGATIVE MAKING

How to develop your first (or your 1000th) roll of film

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THE DEVELOPING and fixing of a film is a very simple process. Anyone can do it easily and cheaply and with very good results. There is, however, one best way to do everything and it is the purpose of this chapter to outline the best way to convert an exposed film into a good set of negatives.

The steps covered are, in order:

1. *Loading the tank.*
2. *Developing the film.*
3. *Rinsing.*
4. *Hardening.*
5. *Fixing.*
6. *Washing.*
7. *Drying and Storage.*

The best method of carrying out each step is described in detail and reasons are given why this or that particular method is recommended. All in all a great many words are used to describe the process, but the amount of talk necessary to tell exactly how it is done does not mean that the process is complicated. Anyone who tries can follow the directions. After a little experience the long list of precautions seems simple and obvious and is followed automatically in practice.

The Photographic Film

A photographic film consists of an emulsion of microscopic silver bromide particles in gelatin, coated on a film of transparent nitrocellulose or cellulose acetate. In making a negative the film is placed in a camera and exposed to the light reflected from some object or group of objects. This exposure produces a "latent" or invisible image. The film is then placed in a developer which converts the latent image into a visible one by changing the exposed silver bromide into silver. The image is then "fixed" or made permanent by putting the film into a fixing bath which dissolves and removes the unchanged silver bromide. After washing and drying, the film is then called a negative because its image, while it has the same outlines as the subject, has the opposite tone values. Thus, the negative is dark where the subject was light, and vice versa.

Negative Making Equipment

The best method of developing roll film is in a spiral-groove tank such as the one illustrated in Fig. 1. Some of these are made for 35 mm film

Fig. 1—An all-bakelite spiral-groove developing tank for roll film.

only, and others are adjustable to take any standard size. The best ones are made of bakelite or stainless steel which are not affected by (nor do they affect) the developer. Hard rubber, if properly compounded, is also satisfactory for tank manufacture, and stoneware or enamelled ware are used for large commercial installations. *The reader is especially warned against using brass tanks* whether nickel or chrome plated, because the plating is usually porous and such tanks often cause the developer to be much more active than it should be, producing fog, dense negatives, and coarse grain.

Once the film is in the tank, development, rinsing, fixing, and washing can all be done without opening the tank or removing the film. The only other equipment needed is a thermometer, a viscous sponge or piece of chamois skin to wipe excess water off the film after washing, and a couple of clips to use in hanging the film up to dry. Various accessories such as agitators, temperature regulators, film drying equipment, etc., are convenient, but distinctly in the luxury class.

For developing cut film or film packs, the spiral groove tanks are not suitable, but there are a number of good tanks on the market for this purpose. Where only a few sheets of cut film are to be developed at one time and where fine grain is not necessary, tray development in a flat, enamelled, glass, or rubber dish is often used. With panchromatic film, however, development must be done in total darkness and the tray method is rather awkward.

Darkrooms and Their Substitutes

Since most of the film used by advanced amateurs today is panchromatic (sensitive to all colors) it must be loaded into the tank in total darkness. If this is done in a darkroom, the user should take precautions to see that it is really dark. Much film has been fogged and streaked by light coming through cracks around doors, in darkroom walls, etc. If in doubt as to whether your darkroom is really dark, go into it and sit in darkness for 15 minutes. Then scan the four walls from various angles and from various positions high and low. If there is the smallest light leak it should be plugged up.

If no darkroom is handy, a changing bag can be used or can be improvised from blankets, tent flaps, raincoats, or whatever is at hand. The writer has used all of these on occasion and, when in the mountains, has even loaded a tank inside a pair of hiking breeches by folding over the top of the breeches and thrusting his arms up the leg openings from the bottom.

Loading the Tank

Loading cut film or pack film into one of the present day tanks is a simple procedure and needs no description. Roll film, however, is sometimes hard to load into the spiral groove tanks because the film tends to stick after it is part way in. To make loading easy, the groove in which the film slides should always be dry. The film will slide more easily if the end entering the groove is cut off square and the first $\frac{1}{8}$ inch of film bent back on itself for a moment in the opposite direction from the natural curl of the film. This straightens out the end of the film and cuts down the tendency to catch in the groove.

If the film tends to stick even after this treatment, it can usually be inserted the rest of the way by taking hold of the reel with the left hand as shown in Fig. 2, grasping the film lightly (with the thumb and finger forming a semi-circle) as shown and sliding the film along with a firm but gentle pressure. The reel can be rotated with the left hand at the same time.

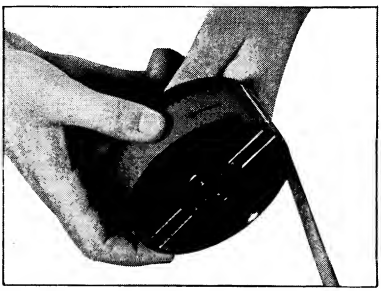

Fig. 2—How to force a sticking roll of film farther into the reel.

Film should always be handled by the edges or the back, to avoid fingerprints on the emulsion.

"Soaking" the Film

After the tank is loaded and the lid securely on, all operations can be carried out in daylight, if the tank is really light-tight. If the tank is very small or is of the "apron" type so that there is not much room between the emulsion and the apron or the next layer of film, it is advisable to soak the film in plain water for 2 or 3 minutes before development to prevent adherence of air bubbles and "relax" the film, which if badly curled will sometimes buckle enough to touch the back of the next film layer. *With the larger spiral groove tanks such as the one illustrated, there is plenty of room between successive layers of film and this "pre-soaking" is a waste of time.* Indeed, there have been cases where pre-soaking the film in tap water has led to coarse grain and fogged film, because the tap water contained traces of chemicals which got into the developer and over-activated it. If by chance a fine grain developer is contaminated in this way, it should be immediately thrown out, because it will fog subsequent rolls of film developed in it.

Development

The developer should be cooled (or warmed) to the temperature at which development is to be carried out. The temperature should be measured accurately with a good thermometer which should be held in the solution for a minute or so before taking a final reading.

The developer should be poured into the tank as rapidly as possible as shown in the accompanying illustration. After development is complete, the developer should be poured out as rapidly as possible and the rinse bath poured in immediately. Developing time should be measured from the moment you *begin* pouring developer into the tank to the moment you *begin* pouring it out. If the tank is filled and emptied as rapidly as possible this method of timing will result in correct development. This is the timing method that is used in working out developing times of all Edwal formulas.

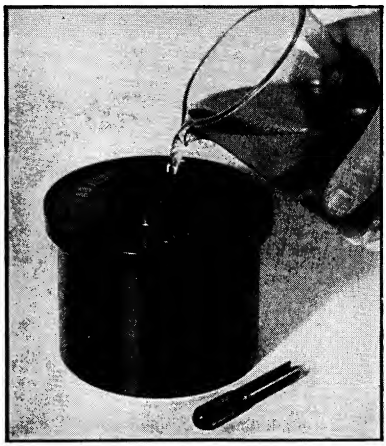

Fig. 3—Pour the developer into the tank as rapidly as possible.

If a bakelite tank is used the variation in temperature during development is seldom more than a degree during the average developing time,

and for practical purposes may be neglected. Metal tanks, however, are better heat conductors than bakelite and the temperature may vary several degrees, especially in warm weather. For this reason it is advisable during development to keep a metal tank in a large dish of water which is at the same temperature as the developing solution. If this is not possible, the temperature should be measured at the beginning of development and again toward the end and the developing time actually used should be based on the average temperature rather than the temperature at the beginning.

Agitation

The film should be agitated vigorously at first by swishing the reel back and forth in the tank (Fig. 4). During development, agitation for 10 seconds every 2 or 3 minutes is sufficient.

A mechanical agitator can be used if desired. If the mechanical agitator rocks or twirls the entire tank back and forth, the developing time should usually be cut 10% below the time given for hand agitation. If the mechanical agitator swishes the reel back and forth inside the tank, the developing time can be cut 20%. These figures have been determined for spiral groove tanks of the type shown in the illustrations. For other types of tanks, comparative tests should be run before applying these percentages. If the film is insufficiently agitated, uneven development results, and, with 35 mm films, streaks running down from the sprocket holes often appear in the emulsion.

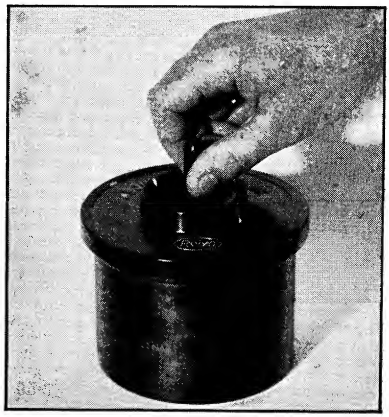

Fig. 4—Agitate by twirling the reel back and forth in the solution.

The Rinse Bath

The best rinse bath for film is distilled water, or plain water which contains 8 or 10 drops of glacial acetic acid per liter. A few crystals of citric acid can be used in place of acetic if this is desired. A strongly acid stop bath should not be used if the developer contains much carbonate or sulphite, as most developers do. If an emulsion that is saturated with

sulphite or carbonate is plunged into a strongly acid bath, bubbles of carbon dioxide or sulphur dioxide form in the gelatin and cause pinholes. If, however, plain water or water containing only a few drops of acetic acid is used, the sulphite or carbonate are soaked out of the emulsion and no pinholes result when the film is placed in an acid fixing bath or a chrome-alum bisulphite hardener (which are both strongly acid). The rinse bath should be at the same temperature as the developer.

If a rinse bath is to be used at 75° F. or higher, Edwal Thermo-Salt should be added to prevent undue swelling of the emulsion which would otherwise take place in the highly dilute solution (see section on Hot Weather Development in Chapter III).

The Hardening Bath

Under ordinary conditions, no separate hardening bath is needed. The alum in an ordinary acid-hypo-alum fixer hardens the gelatin sufficiently. If, however, it is necessary to wash the film in warm water or to make it scratch-resistant, a chrome alum hardening rinse is used between the rinse bath and the fixer. A solution of 20 to 30 grams of chrome alum in a liter of water may be used if desired. Such a solution will retain its hardening power as long as it has a purple color when viewed by transmitted Mazda light. When it becomes yellowish green it should be discarded.

A chrome alum-bisulphite bath is generally used for amateur work. The bisulphite serves to prevent scum formation due to accumulation of alkali from the developer. The formula is:

EDWAL-291—CHROME ALUM-BISULPHITE HARDENER

	Metric	*U. S. Units*
Water	**500 cc**	**1 pint**
Chrome Alum	**10 grams**	**150 grains**
Sodium Bisulphite	**10 grams**	**150 grains**

Film should remain in the above bath for 4 to 6 minutes for complete hardening. This bath should be freshly made, and should be thrown out after a day's use. If it is desired to keep a stock chrome hardener, this may be accomplished by making up separate solutions of chrome alum and bisulphite (40 grams per liter) and mixing equal parts of the two liquids when needed for use.

For those who prefer a prepared chrome hardener we recommend Edwal *New Improved* Chrome Hardener which also contains Edwal Thermo-Salt to prevent emulsion swelling. It is packed in convenient form ready to be dissolved in water.

The Fixing Bath

After the film has been rinsed, and hardened if necessary, it is fixed in an acid-hypo-alum bath. A formula for such a hardening fixer is:

EDWAL-204—ACID-HYPO-ALUM FIXER

	Metric	*U. S. Units*
Water (100° to 125° F)	**600 cc**	**20 ozs.**
Hypo	**240 grams**	**8 ozs.**
Sulphite (Anhydrous)	**15 grams**	**½ oz.**
28% Acetic Acid	**47 cc**	**1½ fluid ozs.**
Boric Acid Crystals	**7.5 grams**	**¼ oz.**
Potassium Alum	**15 grams**	**½ oz.**
Cold Water to	**1 liter**	**1 quart**

Dissolve the chemicals in the order given. Glacial acetic acid (3⅓ drams or 13 cc.) may be used in place of 28% acetic acid if desired. In no case should acid or alum be added to the solution before the sulphite has completely dissolved, since a precipitate of sulphur is apt to form.

Film should be fixed in this bath for at least twice as long as is required to clear the emulsion (i.e. remove the milky appearance by dissolving the silver bromide). For maximum hardening, however, especially after the bath has been used somewhat, film should remain in the fixer for 15 to 20 minutes and this fixing time is recommended even for a fresh bath.

Edwal-204 may be used for films at temperatures up to 75° F. without any supplementary hardening. For processing above 75° F. the film should be hardened in a chrome alum hardener (Edwal-291) before fixing. If this is done the fixer will give satisfactory results up to 90° F. if it is fresh. If the bath is kept at 70° or below, it may be stored for 6 or 8 weeks with perfect safety and may be used over and over until exhausted. For work at 75° or over, a fresh fixing bath should always be used, since with an old fixer, there is a tendency to deposit sulphur in the emulsion and this causes the image to fade during storage.

Prepared Fixers

For those who prefer to use a prepared powder fixer, Edwal Acid Fix is recommended. Edwal Acid Fix contains an anti-precipitant which reduces the tendency to formation of a precipitate during storage and prevents formation of insoluble aluminum salts with developers containing trisodium phosphate.

Two prepared fixers are also available in *liquid* form. One of these, Edwal Liquid Fix, is a standard speed acid hardening fixer which is diluted with 3 parts of water for use. It is much used by amateurs who

prefer not to mix their own fixer. The other, Edwal Quick-Fix, contains a new fixing agent and is used for *high speed* fixing of film. Quick-Fix will completely fix and harden a film in 3 minutes.

A fixing bath should *never* be used:

1. If it tends to froth easily.
2. If a pale yellow precipitate of sulphur has formed in the solution.
3. If it will not clear a strip of film in less than 10 minutes.

All these are signs of exhaustion or the beginning of decomposition and such a fixer is almost certain to spoil the film.

A Chrome Alum Fixer

For work at high temperatures (75° to 90° F.) it is sometimes desired to eliminate the use of a separate chrome alum hardening bath. This can be done if the following chrome alum fixer is used instead of Edwal-204.

EDWAL-205—CHROME FIXING BATH

Solution A	*Metric*	*U. S. Units*
Hypo	960 grams	2 lbs.
Sulphite (Anhydrous)	60 grams	2 ozs.
Water to	3 liters	3 quarts
Solution B		
Water	1 liter	32 ozs.
Chrome Alum	60 grams	2 ozs.
Sulphuric Acid (Pure Conc.)	8 cc	¼ fluid oz.

Mix the chemicals in the order given. Just before using, cool both solutions to 70° F. or lower and pour solution B into solution A with vigorous stirring. If no means of cooling to 70° is at hand, the two solutions may be mixed at higher temperatures (up to 90°) but mixing must be done slowly and with very vigorous stirring. Cold water should be used in making up solution B since if the water is above 125° F. the bath will not harden properly.

Edwal-205 is for a gallon of chrome fixing bath. If less than a gallon is needed, pour 1 volume of solution B into 3 volumes of A. For best results, the chrome fixing bath should be made up fresh each time it is used, though it will retain its hardening properties for 10 days to 2 weeks if stored in a cool place. The stock solutions will keep quite well as long as they are not mixed. Stock solution A should be kept in full, tightly closed bottles if it is to be stored for more than 4 to 6 weeks.

A modification of Edwal-205 is sometimes used containing 4 ozs. of chrome alum and 2½ ozs. of sulphite in place of the quantities specified. Such a bath gives a more powerful hardening action than Edwal-205 but should not be used after it is two days old.

Film should be fixed in Edwal-205 for 20 minutes at 70°. At higher temperatures the time may be reduced about 10% for each 5° above 70° F. if desired. This fixer exerts a very strong hardening action and film fixed in it can be washed in fairly warm water without damage. The film emulsion becomes very tough and scratch-resistant, and after drying can hardly be scratched with the thumbnail.

Washing and Drying

After the film is fixed it should be washed 20 to 30 minutes in running water at 70° to 75° F. This may be done either in the tank or in a shallow tray or pan. The water should circulate vigorously enough so that the entire emulsion surface of the film is thoroughly washed in fresh water. After washing, both sides of the film should be gently wiped with a viscose sponge or chamois which has been wet with water and squeezed out. A cloth may be used, but lint is apt to be left on the film.

The film is then hung up to dry by means of a clip at one end, and a second clip is put on the lower end to act as a weight and keep the strip from curling. Drying should be done in a dust-free room. The best drying time is about 20 minutes. If the air is humid and a longer drying time is necessary, no damage is done. It was once thought that a long drying time increased graininess, but tests have shown that if there is any effect it is so slight that it cannot be measured. If the film is dried very rapidly in a blast of hot air, it sometimes curls excessively and there may be a slight coarsening of the grain structure.

With small tanks it is best to take the film completely out of the tank and wash it in a larger vessel, since circulation is apt to be poor and hypo-removal incomplete if washing is carried out with the film in the tank. Also a certain amount of hypo is apt to remain in the groove of the reel and this contaminates the next batch of developer and causes fog along the edges of the film. This groove should be thoroughly washed after the film is removed, whether the film is washed in the tank or not.

Film may be dried more quickly if a rinse containing a wetting agent is used after washing. Allow the well-washed film to drain and then soak it for 30 seconds to a minute in a bath made up of ten drops of Edwal Kwik-Wet to a quart of water. Make sure that all emulsion surface is reached by the wetting agent bath. The film may then be hung up to dry and since the water will drain off much more evenly with no individual drops left on the surface, the film will dry in about half the usual time.

FOR THE BEGINNER

The directions given in the preceding pages are quite detailed and may appear rather awesome to a beginner. For anyone who is about to develop his first roll of film, the following simplified procedure is suggested:

1. Unless you are experienced in handling chemicals, use a prepared developer, hardener, and fixer. For general work we recommend the liquid Super-12 (or the powder form Edwal-12) as a developer, and Edwal Acid Fix or Liquid Fix as the fixer. If extra hardening is desired, use Edwal Chrome Hardener between the rinse bath and fixing. Sizes, prices, etc., are given in the last pages of this book.

2. Load the film into the developing tank as described earlier in this chapter. Always handle film by the edges.

3. Be sure the developer, rinse bath, and fixer are all at 70° (or whatever temperature is specified).

4. Pour in the developer, and agitate the film vigorously. Agitate every 2 or 3 minutes during development.

5. Measure the developing time from the moment you *begin* pouring developer into the tank to the time you *begin* pouring it out. Use the developing time recommended for the film you are using.

6. When development is complete, pour the developer out of the tank, and pour in a rinse bath consisting of a few drops of acetic acid in plain water. Agitate as during development.

7. After 4 or 5 minutes, pour the rinse bath out of the tank and pour in a solution of Edwal Chrome Hardener. Agitate as usual. Allow the film to remain in the hardener for 4 to 5 minutes. (This step may be omitted if extra hardening is not desired.)

8. Pour out the Chrome Hardener and pour in Edwal Acid Fix, or Liquid Fix. Agitate occasionally. Fix 20 minutes.

9. Pour out the fixer and wash the film in running water for 20 to 30 minutes. If the temperature of the wash water is somewhat different from that of the developer, fixer, etc., this does not matter.

10. Rinse film (after washing) for 30 to 60 seconds in a solution of 10 drops of Edwal Kwik-Wet to a quart of water. This eliminates waterspots and cuts drying time in half. Wipe the droplets off both sides of the film with a damp viscose sponge or chamois and hang it up to dry.

11. After drying, the film may be rolled up for storage in cans, or cut into strips or separate negatives. For prolonged storage, metal containers are recommended.

Chapter II

ELEMENTARY PHOTOGRAPHIC CHEMISTRY

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A developing solution must contain:

1. A developing agent (also called a reducer) which will convert exposed silver bromide into silver, but will not affect silver bromide that has not been exposed.

2. A preservative which will keep the developing agent from being destroyed by the oxygen taken up from the air during use.

In many developers there is also an alkali, called an accelerator because it speeds up the action of the reducing agent, and a restrainer, usually potassium bromide, which prevents fog. It will be the purpose of this chapter to outline the functions of the various ingredients in developing and fixing solutions so that the user will have a better understanding of why these solutions produce the results they do.

Developing Agents

There are 11 developing agents in common use in this country. These are listed in the accompanying table.

Developing agents, such as metol, amidol, etc., are commonly sold in amber glass bottles, and these are the best containers for storage, since they are moisture proof and air tight. It is easy to tell whether a developing agent has deteriorated through atmospheric oxidation, because when badly oxidized it becomes brown or dark purple or black. Most developing agents are white or nearly so when marketed by the manufacturer and as long as the bottle is unopened, there is little chance of serious spoilage. Amidol will sometimes turn gray or acquire a few dark specks, Diamine-P (paraphenylenediamine) will sometimes acquire a slight purple color, and Monazol (glycin) or C. H. Q. (chlorhydroquinone) will occasionally become light tan, if left in a warm place for a long time, but these minor color changes do not indicate any detectable difference in developing power.

However, if a developing agent is exposed to very damp air it takes up a little moisture and this will often cause it to oxidize seriously later on, especially if a partly filled bottle is exposed to strong light or heat for several weeks. Therefore, keep your developing agents dry, cool, and out of the sunlight.

All developing agents will cause stains if the dry powder is allowed to remain on cloth or paper for several days, especially in damp weather.

Table I—COMMON DEVELOPING AGENTS

Trade Names	Chemical Name	Reduction Potential	Speed of Oxidation by Air: SOLID	Speed of Oxidation by Air: IN DEVELOPER	Precautions (See Note) In Handling: DRY POWDER	Precautions (See Note) In Handling: IN DEVELOPER
1. *Amidol*	Diaminophenol hydrochloride	35	Rapid	Very Rapid	Stains / Toxic	Non-staining / Toxic
2. *Metol*, Elon, Rhodol, Pictol, Monotol, Veritol	Mono-methyl para-aminophenol sulphate	20	Slow	Rapid	Toxic	Toxic
3. *Pyro,* Pyrogallol	1, 2, 3-trihydroxybenzene	16	Slow	Rapid	Stains	Stains
4. *Chlorhydroquinone* Adurol, Edwal C.H.Q	1, 4-dihydroxy-2-chlorobenzene	7	Slow	Medium	Non-toxic	Non-toxic
5. *Pyrocatechin* Edwal Catechol	1, 2-dihydroxybenzene	7	Slow	Medium		
6. *Gradol*		6	Slow	Medium	Toxic	Toxic
7. *Kodelon*	Para-aminophenol hydrochloride	6	Slow	Medium	Toxic	Toxic
8. *Glycin* Monazol	Para-hydroxyphenylamino acetic acid	1.6	Medium	Slow	Non-toxic	Non-toxic
9. *Hydroquinone*	1, 4-dihydroxybenzene	1	Slow	Medium	Non-toxic	Non-toxic
10. *Paraphenylene-diamine* Edwal Diamine-P	1, 4-diaminobenzene	0.4	Medium	Slow	Stains / Toxic	Stains / Toxic
11. *Orthophenylenediamine* Edwal Orthamine	1, 2-diaminobenzene		Slow	Slow		

Note: The developing agents mentioned as "toxic" will produce a severe skin rash on people who are allergically sensitive to them. Most people are not sensitive, however, and can handle any developer without trouble. Those listed as "non-toxic" have little or no tendency to cause rash, as far as is now known. Those for which no information is given have not been used widely enough to establish definite information. A person who is sensitive to metol, may not be sensitive to Kodelon or Diamine-P, etc. However, persons who are sensitive to all the so-called "toxic" agents can usually employ a film developer such as Edwal-102 which contains Monazol. All common developing agents are toxic in the true sense of the word, for they are poisonous if actually eaten.

Most developing solutions are non-staining if washed off within a reasonable length of time. Only those which cause severe stains if allowed to dry on the hands are listed in the table as stain-producers. Even these (except, perhaps, pyro) will not stain if washed off within a few minutes with plenty of soap and water.

Preservatives

The most common preservative is sodium sulphite, though sodium bisulphite, potassium metabisulphite, and sugar are also used. Sodium sulphite is generally used in the water-free or anhydrous form, and is specified in photographic formulas as Sulphite (anhyd.) or Sulphite (desiccated). If it is allowed to stand in moist air it is partly oxidized into sodium sulphate. Some water is also taken up as water of crystallization and the resulting mixture has less preservative action, weight for weight, than pure sulphite. Because of this, photographic sodium sulphite should always be kept in closed, air-tight containers.

Sodium sulphite is a mild alkali as well as a preservative, and in many fine grain developers no other alkali is used. Commercial grades sold for photographic purposes contain small amounts of sodium carbonate, a stronger alkali, which in a fine grain developer will cause undue activity of the developer and unnecessarily coarse grain. Tests have shown that the amount of carbonate varies appreciably from one lot to the next, and fine grain developers made from different lots of sulphite have varied in activity as a result. To remedy this situation, Edwal Fine Grain Sulphite is standardized to a definite pH value (degree of alkalinity) and is made uniform especially for fine grain work. It is specified in all Edwal formulas and should be used wherever the best possible results are desired.

Alkalies and pH

Any developing agent works more vigorously in a strongly alkaline solution than in a less alkaline one. A very common measure of alkalinity is the pH number, which to a chemist is the logarithm of the reciprocal of the hydrogen ion concentration. The practical photographer need only remember that the pH numbers run from zero to 14. A pH of zero represents a strongly acid solution, a pH of 7 represents a neutral solution or pure water, and a pH of 14 represents a strongly alkaline solution.

Since the pH is a logarithm, a small change in pH represents a large change in actual alkalinity. Thus a solution whose pH number is 9 is ten times as alkaline as a solution whose pH is 8, which in turn is ten times as alkaline as a solution whose pH is 7, etc.

The alkalies which are commonly used in developers are (in order of decreasing strength), sodium hydroxide, ammonia, trisodium phosphate, potassium carbonate, sodium carbonate, potassium metaborate (Ko-

dalk), and borax. In general the stronger alkalies are used with the less vigorous reducing agents and vice versa. Thus, sodium hydroxide is used with hydroquinone, T. S. P. with Monazol, the carbonates and Kodalk with metol developers, and no alkali (aside from sulphite) with amidol.

It is characteristic of all the alkalies except borax, that they readily absorb carbon dioxide and water from the air and become weaker if not kept in a closed container. The addition of one of the stronger alkalies to any developer will make it more active and in the case of paper developers this is sometimes desirable.

Restrainers

Most developers tend to produce a certain amount of fog; that is, they tend to deposit silver in unexposed parts of the negative. This tendency is greatly restrained by the addition of small amounts of potassium bromide or sodium bromide. The addition of bromide also reduces the speed of development somewhat and cuts down the density in the thinner parts of the image. Hence the custom is to add just enough bromide to prevent fog without cutting down the developer activity any more than necessary. Since most negative emulsions contain some soluble bromide, this constituent is often omitted from film developers.

Other restrainers are sodium chloride (much less effective than bromide) and Edwal Orthazite which is used in place of bromide in order to get blue-black tones with metol-hydroquinone developers or with Edwal-110. Potassium thiocyanate is also used as a restrainer in a number of fine grain developers, but this substance, while it restrains development if added in small amounts, tends to promote fog if added in larger amounts and hence must be used very carefully.

Water

Water is used in every developer and is often the most impure component of the solution. City water is usually treated with chlorine, lime, or other chemicals, to make it fit for drinking and it sometimes contains iron salts and other impurities. Sometimes traces of copper, zinc, or tin salts are taken up from brass plumbing fixtures and the resulting water causes fog in developers. Sometimes the water is alkaline (Chicago water has a pH of about 8) and should not be used in fine grain developers which should operate at a pH of 7.5.

Usually distilled water is recommended for all photographic solutions, but distilled water may be hard to get. Rain water is a fairly good substitute, except in industrial regions where the air is full of sulphurous gases and all kinds of suspended solid matter. For making fixing baths and acid stop baths almost any kind of water will do. For making

alkaline developers, most city water can be used if necessary, but water containing iron or heavy metal salts or soluble sulphides should be avoided. For fine grain developers, however, the best water obtainable should always be used, preferably distilled, because tap water or surface water almost always increases the amount of fog and gives an inferior negative.

When distilled water is not conveniently available, water pure enough for photographic uses may be obtained by collecting the water released during defrosting of a mechanical refrigerator (either gas or electric power). If there are any food odors noticeable, boiling will drive them out. If there is any lint or sediment in the water thus collected, filter it before using.

Fixing Solutions

Exposure and development use only about a *quarter* of the silver salts in the emulsion; all the rest must be removed if the image is to be permanent. This is the job of the fixing process; it removes the *unused* silver salts and "fixes" the image.

The main ingredient of all fixing baths is a "fixing agent" which will dissolve silver salts (common ones are sodium thiosulphate, ammonium thiosulphate, potassium thiocyanate, and potassium cyanide). The commonest of these is sodium thiosulphate (hypo) but its action is fairly slow. Potassium cyanide is used for extreme speed but it is exceedingly poisonous. Ammonium thiosulphate fixes with great speed and is completely non-poisonous. The photographic grade is sold by Edwal under the name "Thiamate" to distinguish it from commercial grades. It has three times the fixing power (weight for weight) of ordinary hypo and is used as the basis of the high speed fixer "Quick-Fix."

There are several steps in the fixing process, all of which must be completed if fixing is to be thorough. In these steps, the "fixing agents" mentioned above must react with the silver salts in the emulsion, and give a product which is easily soluble in water. The universal practice is to leave film in the fixing bath *twice* the time it takes to clear, to be sure that the reaction has completely done its job. Too long a time in a fixing bath will lead to bleaching (loss of some of the silver forming the image) or in old fixing baths, to toning of the image to an off-color black.

For dissolving silver bromide, a plain solution of a pound of hypo (sodium thiosulphate) in two quarts of water is satisfactory. However, in practical work a fixing bath is used several times, and in order to prevent the developer which gradually accumulates in the hypo from remain-

"March Night" *Ralph Hamman*

From an Edwal-20 negative. Print developed in Edwal-126. This picture has been accepted and hung in 15 international salons.

ing active, a certain amount of acid is added, usually acetic or sodium bisulphite.

An acid solution of hypo is unstable and gradually precipitates sulphur as a pale yellow finely-divided solid. To prevent this, a small amount of sodium sulphite is put into the fixing bath. Such a fixer containing hypo, sodium sulphite and acid is quite stable and will fix satisfactorily. The emulsion as it comes from the developer or the stop-bath is usually quite soft, and to remedy this a tanning agent such as potassium alum or chrome alum is added to the fixer. The result is the standard acid-hypo-alum hardening fixer. Edwal Acid-Fix is a prepared fixer of this type. It is packaged in such a way that the hardening constituent may be omitted if desired by the user, so as to make a non-hardening fixer which is desirable with prints to be toned.

The amount of film or paper a fixing bath will handle depends upon the "fixing agent" with which it is made. Plain acid hardening fixers made with hypo will handle about 1,000 square inches of film or paper per quart. The high-speed concentrated liquid stock-solution fixers, such as Edwal Quick-Fix (made with Thiamate) will handle 2 to 3 times as much.

Testing Fixing Baths

Determination of the "clearing time" of a fixer is the best test of its condition, since films and prints should be fixed *twice* the clearing time.

Half inch strips cut from an inexpensive roll-film will do very nicely for this test. One roll (even an outdated one will do) will give enough pieces to last a long time. Soak the test strip three or four minutes in water and then place it in the fixer to be tested. When the milky appearance (under ordinary light) has disappeared and the film has become transparent, it is said to have "cleared."

Acid-hardening hypo fixers should be discarded when the clearing time takes *twice* as long as when fresh. With the *high-speed* (*Thiamate*) fixers, *six* or *seven* times the original clearing time is a safe limit before discarding.

An easier test for a hypo type fixer which will tell whether a fixing bath is safe to use or not is to shake a few drops of Edwal Hypo-Chek into the bath. If it remains clear, the bath is still satisfactory; if a cloudy precipitate forms, the bath is exhausted and should be discarded.

The two tests mentioned above test only the *fixing power* of the bath. In general use, the *acidity* of a fixer may be exhausted by excessive carry-over of developer on films or prints before the fixing power is exhausted. The use of rinse baths and stop baths will reduce this loss of fixer acidity, which ruins a fixer. If the acidity drops too low, and the fixing power is still high, addition of Acetic Acid or Edwal Signal will make continued use possible. Edwal Signal would be best since it contains a color indicator which changes color when the *acidity* of a solution containing it is exhausted.

Washing of Films and Prints

Since the fixing process is not complete until the excess fixer and the silver thiosulphate complexes have been washed away, care is needed to see that the films or prints are properly washed. Traces of the fixing agent, or its reaction products, left in a film or print, will eventually decompose to form sulphide compounds which will then partially sulphide-tone the image, usually in spots and streaks of brown or yellow. Washing times recommended by film-makers are sufficient when the films or prints are well agitated in the wash water and there is certainty that the water

in motion reaches *all* surfaces of the films or prints. With long lengths of roll films, the tendency to coil up tightly can be counteracted by looping the film against its natural curl in a large circle and clipping the ends together. If many prints are being washed in a small volume of water, they must be shuffled often to insure real washing. If prints or film have been fixed longer than the recommended times, much longer washing times will be necessary as shown in Table II, which gives washing times for papers which have been fixed the normal time and also for those which have been fixed twice as long as is necessary.

WASHING TIMES

Times, *in minutes,* for washing *double weight* photographic paper after fixing. (Films and *single* weight prints will wash in *half to two-thirds* the times listed below.) Notice particularly how much longer washing times are required when fixing is needlessly carried on beyond normal requirements.

TABLE II

Wash water temperature	Washing Time After *Normal* Fixing Time		Washing Time After *Twice Normal* Fixing Time	
	50° F	75° F	50° F	75° F
1) Liquid-Fix (1:3)	30 min.	20 min.	75 min.	30 min.
2) Quick-Fix 1:3 dilution with its hardener	25 min.	15 min.	45 min.	30 min.
3) Quick-Fix at 1:7 dilution with its hardener	60 min.	20 min.	100 min.	40 min.
4) Quick-Fix at 1:3 dilution no hardener (for prints to be toned)	25 min.	15 min.	45 min.	30 min.
5) Quick-Fix at 1:7 dilution without hardener (for prints to be toned)	45 min.	14 min.	75 min.	30 min.

Chapter III

EDWAL DEVELOPERS FOR FILM

SINCE the introduction of the miniature camera the cry has been for developers that would produce finer and finer grain. In fact, fine grain developers have been so much emphasized that many photographers do not realize that the developer is only one of three important factors in determining graininess, the other two being, exposure and developing time. There has also been a tendency to forget the fact that no one developer is suited to any and every type of photographic work.

It has been the purpose of The Edwal Laboratories to manufacture the purest developing agents that can be made, to publish satisfactory formulas for their use, and to give as much information as possible concerning the use of these formulas in various types of photography. Hence in this chapter are given the various Edwal formulas, with full instructions for handling each one, and an explanation of their developing characteristics. Some general discussion of fine grain and other developing problems is given first, together with a comparison of the various developers. The various formulas with developing data follow.

Grain

The graininess produced by any developer depends largely on the alkalinity of the developer and on the length of time it takes for that developer to produce a given degree of contrast. In general, the lower the alkalinity, the finer will be the grain. Furthermore a slow-working developer (i.e. one that requires a long time to build up a normal amount of contrast) generally gives finer grain than a fast working one. Thus Edwal-12 produces finer grain than Edwal-10 or D-76 because Edwal-12 is less alkaline (pH 7.5) than Edwal-10 (pH 8.3) or D-76 (pH 8.6). Similarly Edwal-20 produces finer grain than Edwal-12 because the former is slower working than the latter. Formulas which are claimed to produce very fine grain with a short developing time always do so at the expense of full contrast.

With any particular developer, finer grain is always obtained in a relatively thin negative rather than in a dense one. Finer grain is also obtained with a given developer if developing time is shortened so as to produce low contrast. Coarse grain is obtained if development is prolonged so as to give stronger contrast.

Torkel Korling

From an Edwal-12 negative. Made by Mr. Korling for the Minnesota Valley Canning Co.

The essentials, therefore, in obtaining fine grain are:

1. Pick a slow-working developer of low alkalinity.

2. Keep the exposure down so as to have a fairly thin negative.

3. Do not develop longer than is specified in the directions given with the developer — in fact, if your subject is rather contrasty (e.g. brilliant sunlight and deep shadows) you can under-develop 10 or 20 per cent.

In general the developers containing Diamine-P are much more effective than those not containing this chemical in producing fine grain on the high speed films. With the medium-speed "fine grain" films this difference is not marked. Thus, on Finopan or Panatomic X, Minicol (a non-diamine developer) produces somewhat finer grain than Edwal-20. On Agfa Ultra Speed or Dupont Superior No. 3, however, Edwal-20 gives considerably finer grain than Minicol.

D-76 and Edwal-10 are classed as semi-fine grain developers and in ordinary work will give negatives capable of 6 to 10 diameter enlargements. Edwal-12 and Edwal-36 are fine-grain developers, producing negatives capable of 12 to 20 diameter enlargements, and Edwal-20, Edwal-32 and Minicol are called "super-fine" grain developers, since their negatives allow enlargements to 25 diameters or more.

These figures are, of course, for average work. On a dense (over-exposed) or contrasty (over-developed) negative, grain will show at 5 or 6 diameters with Edwal-10, at 10 or 12 diameters with Edwal-12 and at 15 diameters with Edwal-20. On the other hand with a low-density negative, enlargements to 25 diameters can be made with Edwal-12 and 40 or 60 diameters with Edwal-20 or Minicol. Enlargements even to 100 diameters are possible because, once past 60 diameters, the definition becomes so poor, the grain will not show up clearly anyway.

In spite of claims to the contrary, there is no fine grain developer that produces a higher effective emulsion speed than the borax type developers such as Edwal-10 or D-76. All the developers which produce appreciably finer grain than these, also cause some loss of emulsion speed. It is generally true that developers which contain Diamine-P cause less loss of speed than other developers which produce equivalent fineness of grain. Thus, Edwal-12 which produces considerably finer grain than the borax developers, causes relatively little loss of speed. Because of the evenness of the grain structure, a relatively thin negative can be used, and hence Edwal-12 should be used with ½ the so-called "normal" exposure on 35 mm films, and about 2/3 normal on larger roll films. Edwal-20, Edwal-32, and Minicol require about twice as much exposure as Edwal-12 or the borax-type developers. Thus, Edwal-20 requires the

full "normal" exposure on 35 mm film and 50% more than normal on large negatives. Edwal-36 falls about halfway between Edwal-12 and Edwal-20 as far as emulsion speed is concerned.

Contrast

Contrast is generally defined as the difference in density between the blackest parts of the negative (highlights) and the thinnest portions (shadow areas). If this difference is great the negative is called hard or contrasty. If the difference is slight the negative is weak or flat. With any developer, an increased developing time produces increased contrast and is sometimes used to "snap-up" dull, softly-lighted subjects. Decreasing the developing time decreases contrast and is sometimes resorted to when the subject is brilliantly lighted so that highlights are very bright and shadows are very deep. With very contrasty subjects, however, it is better to develop fully with a soft working developer like Minicol than to underdevelop with a full scale developer like Edwal-12 or Edwal-20.

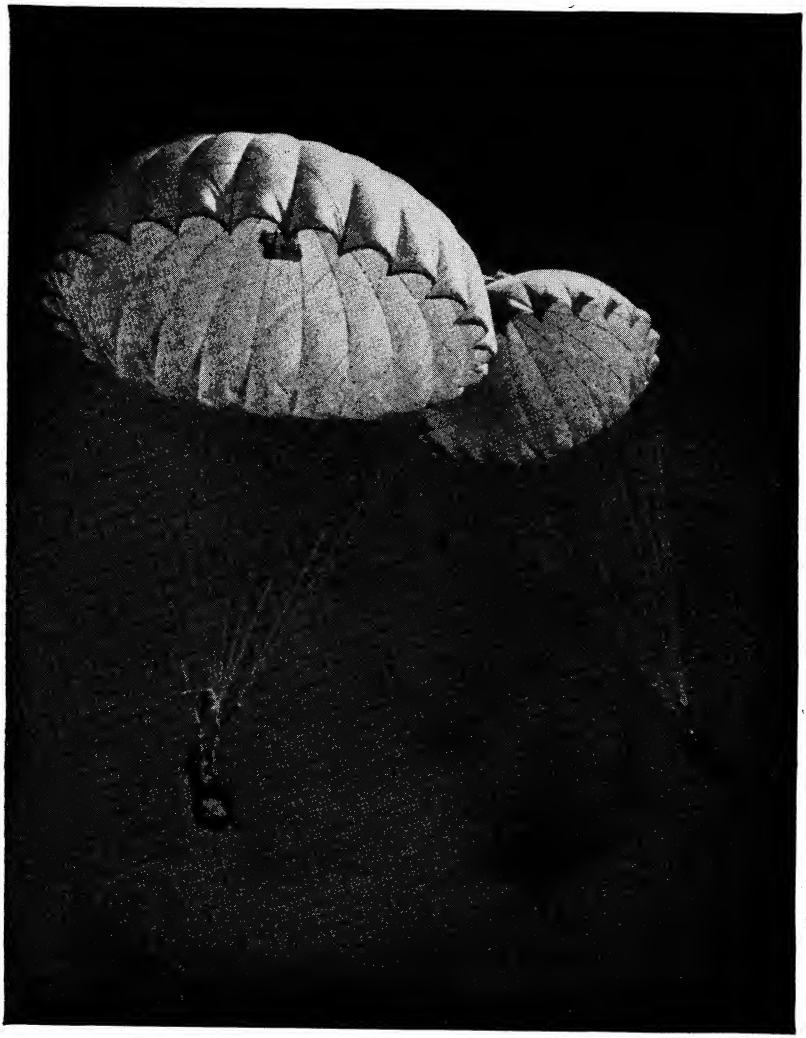
Gamma

Gamma is a mathematical concept used in sensitometric work where a more accurate measure of contrast is needed than the "high-contrast" and "low-contrast" which suffice for the practical photographer. When a film is given a series of greater and greater exposures and developed in a fresh developer at a very exactly measured temperature and for a definite length of time, a series of greater and greater densities is obtained on the film. Gamma is calculated by determining the mathematical difference between two densities in this series and dividing the number so obtained by the mathematical difference between the logarithms of the corresponding exposures. In other words

$$\text{Gamma} = \frac{D(\text{max}) \quad - \quad D(\text{min})}{\log E(\text{max}) \; - \; \log E(\text{min})}$$

The full explanation of this can be found in any of the standard theoretical books on photography but is beyond the scope of a practical darkroom manual such as this. The only thing the practical photographer needs to know is that gamma expresses the relation of the contrast in the photographic image to the contrast in the original subject. Thus a gamma of 1 means that the contrast in the negative is the same as in the original subject, a gamma of less than 1 means that the negative contrast is less than that of the subject, etc. The usual practice is to develop negatives to a gamma of .7 to .9 except where very strong contrast is wanted in the final print.

Gamma itself is almost never used by the amateur photographer and he can forget it if he wishes. The "time-gamma" tables and curves of



"Sky-Riders" *J. Winton Lemen*

From a 35 mm negative developed in Edwal-12

the sensitometric worker are of little or no use in practical photography, because it is seldom that two batches of film produce exactly the same gamma even when developed in the same manner; and no developer which is used over and over produces the same gamma on two successive rolls of film. The attainment of an exact value of gamma is of little importance because the latitude inherent in printing papers and methods of developing them more than compensates for small differences in negative contrast.

Density

If a negative has a heavy silver deposit so that it transmits relatively little light, it is said to be dense or "heavy." On the other hand if there is little silver in the image, the negative is called "thin." Density is controlled almost entirely by exposure. In fine grain work, especially with 35 mm film, it is advisable to make several exposures of different lengths (e.g. 1/8, 1/4, 1/2 normal and full normal with Edwal-12) and then use the thinnest negative that has the necessary detail and gradation. If a negative is too thin, print quality is apt to be poor.

Density is also controlled to some extent by developing time, because more silver can be deposited in a long time than in a short one. However, prolonged development always builds up the silver deposit in the dense portions (highlights) much more than in the thin portions (shadows) with the result that very strong, unnatural contrast results. Sometimes very bad under-exposures can be saved by developing 45 minutes in Edwal-12 or 60 minutes in Edwal-20 but this should never be done unless the film is known to be badly under-exposed. The grain is always made coarser by prolonged development.

Unsatisfactory Negatives: Tracing Causes

A thin negative may be the result of under-exposure or under-development. In deciding which type of intensification would help most, it is necessary to determine which type of under-timing caused the thin image.

Users of 35 mm film can do this by comparing the edge-numbering on a roll of film in question with those on a normally developed roll. These edge-numberings and brand markings are exposed normally at the factory, so if they are thinner on a particular roll of film than on a normally developed roll, the thinness of the negatives is due to under-development. However, if negatives are thin and the edge-numbering is perfectly normal, the thinness is due to under-exposure. The edge-markings of different manufacturers differ in density, and sometimes vary over long periods of time, so that when making such a comparison films of the same make and of nearly the same expiration date should be used.

Negative Quality

The term negative quality is rather indefinite and has been used to cover a number of things such as gradation (the exactness with which tones in the negative represent light values in the subject), tone separation (whether closely related tones are distinctly separated or "run into each other"), etc. In judging whether negative quality is good or bad the ultimate test is whether or not the negative will give a good print. If the negative quality obtained from a developer is consistently bad, the user should try another formula.

The majority of the developers now on the market produce fairly good negative quality, though there are some that ought never to have been invented and there are others which disappoint their users because impossible claims are made for them.

All the present Edwal formulas will give good negative quality if correctly used.

FOR THE BEGINNER

Lest the beginner be appalled by the prospect of keeping half a dozen different developers on the shelf, it should be said that a single developer will give reasonable satisfaction in most amateur work, especially if a little care is used to regulate the developing time according to the lighting and type of subject. In northern United States or Canada, Edwal-12 or Edwal-20 are recommended, the choice depending on the fineness of grain necessary. In the Southern States, Mexico, or tropical regions, Minicol or Edwal-32 are more suitable.

FOR THE ADVANCED WORKER

As the photographer acquires experience in handling and judging light, increases his knowledge of films, paper emulsions, etc., he becomes more critical of his own results. He will then appreciate the desirability of using the particular developer that suits the type of lighting and the final result he wants. Specific suggestions along this line are found in Chapter VII.

EDWAL-10

For enlargements to 6 or 10 diameters (maximum emulsion speed).

	Metric	*U. S. Units*
Water	**900 cc**	**30 ounces**
Metol (Elon, Pictol)	**5 grams**	**75 grains**
Fine Grain Sulphite	**100 grams**	**3 1/3 ozs.**
Monazol	**5 grams**	**75 grains**
Borax	**10 grams**	**150 grains**
Water to make	**1 liter**	**1 quart**

This developer is recommended for use in place of the metol-hydroquinone-borax type developers. It contains Monazol which is more active than hydroquinone in the presence of weak alkalis such as borax, and hence gives much better gradations in the middle tones and high-light regions. It is recommended for fine grain development of large negatives where a relatively high density is needed. With miniature negatives it can be used with half normal exposure or even less. Suggested life: 8 to 12 rolls of film (35 mm or 2¼ x 3¼) per quart.

DEVELOPING TIMES IN MINUTES FOR EDWAL-10

(See end of chapter for classification of films)

Temperature	Class I	Class II	Class III	Class IV	Class V	Class VI	Class VII
65° F. (18°C)	8	10	12	15	18	22	26
70° F. (21°C)	6	8	10	12	15	18	22
For temperatures above 75° F. add one measure of Edwal Thermo Salt per pint and develop:							
75° F. (24°C)	6	8	10	12	15	18	22
80° F. (27°C)	5	6	8	10	12	15	18
85° F. (30°C)	4½	5	7	8	10	12	15

EDWAL-12

For enlargements to 15 or 20 diameters (maximum emulsion speed).

	Metric	*U. S. Units*
Water (distilled)	**900 cc**	**30 ozs.**
Metol	**6 grams**	**90 grains**
Fine Grain Sulphite	**90 grams**	**3 ozs.**
Diamine-P	**10 grams**	**150 grains**
Monazol	**5 grams**	**75 grains**
Water to make	**1 liter**	**1 quart**

(Available in prepared form)

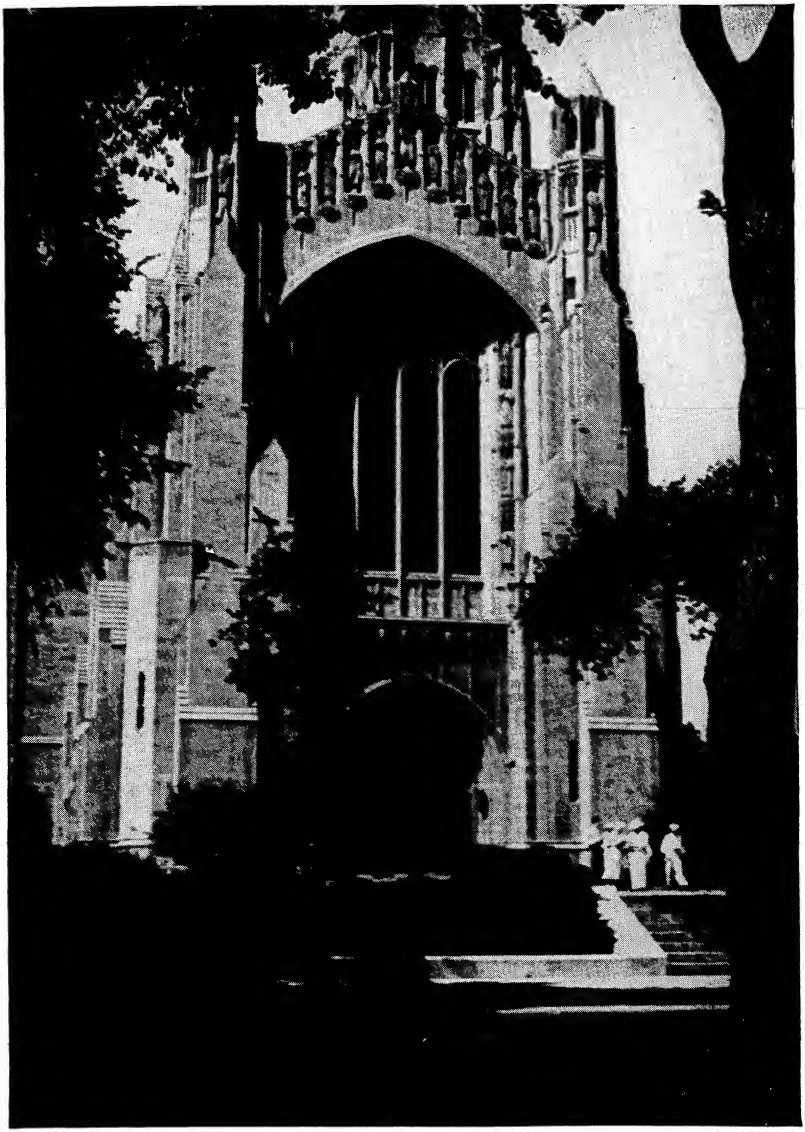
Edwal-12 gives best results with ½ the normal exposure for miniature size film based on the American film manufacturers' speed ratings. Full normal exposure usually produces a negative which is not only too dense but is grainier than necessary.

DEVELOPING TIME TABLES FOR EDWAL-12 AND SUPER-12

Where no times are given in the table, development under those conditions is not recommended.

Developer (and its condition)	Method of use	Temperature °F	Temperature °C	Developing Times, In Minutes (By Film Classes) *Times for developers containing Thermo-Salt are printed in bold face type													
				I	*	II	*	III	*	IV	*	V	*	VI	*	VII	*
Edwal-12 (fresh)	Regular or Replenishment Method (1st film only)	65	18	8	10	10	12	12	15	15	18	18	22	22	26	26	31
		70	21	6	8	8	10	10	12	12	15	15	18	18	22	22	26
		75	24	5	6	6	8	8	10	10	12	12	15	15	18	18	22
		80	27	—	5	—	6	—	8	—	10	—	12	—	15	—	18
		85	30	—	4	—	5	—	6	—	8	—	10	—	12	—	15
Edwal-12 (used)	Regular** or Replenishment Method	65	18	10	12	12	15	15	18	18	22	22	26	26	31	31	37
		70	21	8	10	10	12	12	15	15	18	18	22	22	26	26	31
		75	24	6	8	8	10	10	12	12	15	15	18	18	22	22	26
Super-12 (fresh or used)		80	27	—	6	—	8	—	10	—	12	—	15	—	18	—	22
		85	30	—	5	—	6	—	8	—	10	—	12	—	15	—	18
Edwal-12 (fresh)	Dilution Method (every film)	65	18	16	20	20	24	24	30	30	36	—	44	—	52	—	62
		70	21	12	16	16	20	20	24	24	30	30	36	—	44	—	52
		75	24	10	12	12	16	16	20	20	24	24	30	30	36	—	44
Super-12 (fresh)		80	27	—	10	—	12	—	16	—	20	—	24	—	30	—	36
		85	30	—	8	—	10	—	12	—	16	—	20	—	24	—	30

**When used by the *Regular Method* the developing time should be increased 5% for each roll of 35 mm. film (60 square inches) or equivalent area of other film after the first 10 rolls (600 square inches) have been developed in one quart developer. The recommended life is 12 to 15 rolls per quart but 20 rolls can be developed if necessary.



Chapel, University of Chicago

This picture was made by Dr. E. W. Lowe in 1932 from a negative on the first full roll of film ever developed in Edwal-12.

Edwal-12 is designed for general use in the northern part of the United States where outdoor lighting is often soft, and sometimes downright flat. Hence Edwal-12 can be made to produce very strong contrast if desired, by increasing the developing times. If still stronger contrast is desired, it may be obtained by increasing the amount of Monazol up to a maximum of 10 grams per liter. On the other hand, if a softer working developer is desired, as in color-separation work, the Monazol content may be decreased to 2 grams per liter.

Edwal-12 May Be Used in Any One of 3 Ways

1. *The Regular Method* whereby the developer is used over and over until exhausted. If it is freshly made up, the developing time is 20% less on the first batch of films to avoid too strong contrast and coarse grain. If 20% of old, used Edwal-12 is added to each new batch the initial period of high developing energy is eliminated. If the developer is stored in a quart bottle, 6 ounces of the fresh solution may be poured into a small bottle when the developer is made up, and 6 ounces of old solution added to the remaining 26 ounces of fresh developer. Then, as a little solution is lost each time a roll (60 square inches) is developed, the loss is made up from the 6 ounces of fresh solution in the small bottle.

The developing time should be increased 5% for each roll of 35 mm film (60 square inches) or equivalent area of other film after the first 10 rolls (600 square inches) have been developed. The recommended life is 12 to 15 rolls per quart but 20 rolls can be developed if necessary.

2. *The Replenishing Method* is preferred by many people because it eliminates the gradual loss in developing energy that occurs with method No. 1 and at the same time avoids the initial period of high energy that is encountered with a fresh developer. The replenishing method is:

A. Develop four 60 square inch rolls of film per quart of fresh solution (or 2 rolls in a quart that has 20% of old Edwal-12 added).

B. Discard enough solution so that 29 ounces remain and add 3 ounces of fresh Edwal-12 from another bottle.

C. From this point on repeat the replenishment *after every roll,* discarding enough solution so that 3 ounces of fresh solution can be added for each 60 square inches developed per quart. A good plan is to pour 3 ounces of fresh developer into the quart storage bottle while a film is being developed, and then pour in developer from the tank until the bottle is full. The last ounce or two remaining in the tank after filling the bottle is then poured down the drain.

A quart of Edwal-12 will last indefinitely when used by this method as long as the solution is not unnecessarily exposed to air. If this should happen and the developer becomes weak, it can be brought up to standard strength by discarding twice as much solution and adding 6 ounces of fresh developer instead of the usual 3 ounces. As the developer is used, a certain amount of silver precipitate will accumulate. After developing 20 or 30 rolls this can be allowed to settle and the clear solution poured off. Then the precipitate can be thrown out. If the precipitate does not settle well the solution can be filtered every twenty rolls or so.

A 32 oz. (or larger) bottle of working solution is recommended for Edwal-12 used by this method since developer exhaustion is due not only to development of the image itself, but also to reduction of dissolved silver bromide, atmospheric oxidation, etc., and greater uniformity is obtained with a large quantity of working solution, even though only 8 oz. or 16 oz. is withdrawn at a time to develop film. The amount of replenishing solution to be used each time depends on the amount of film developed (not the size of the stock bottle or tank) and should be 2 oz. for 40 square inches (or less) of emulsion, 3 oz. for 60 square inches, 4 oz. for 90 square inches and an additional ounce for each additional 25 square inches developed at one time.

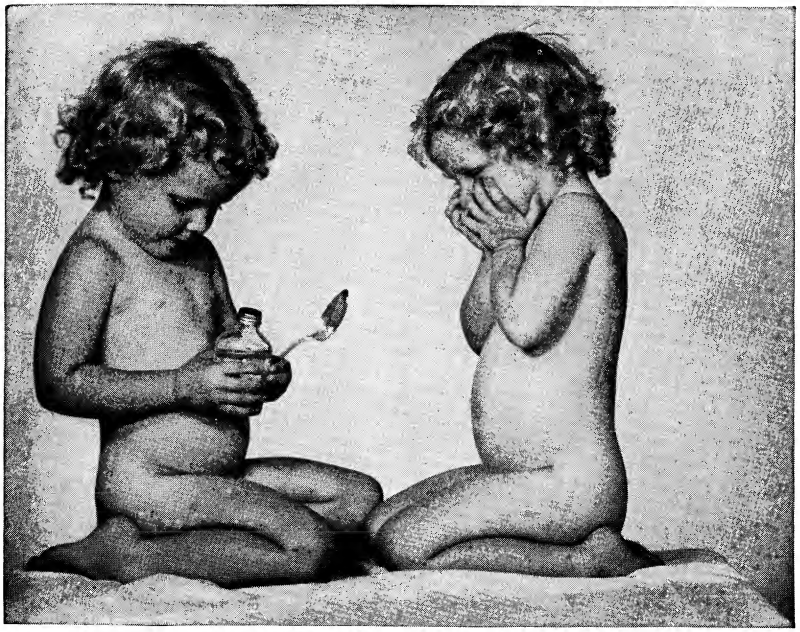
3. *The Dilution Method* is the simplest and in some respects the best. Freshly mixed, unused developer should be employed. The method is:

A. Dilute one part of the developer with 9 parts water (e.g. 50 cc developer with 450 cc water).

B. Develop one roll of film in each tank of developer. Then discard the solution. A pint (500 cc) of diluted developer will process up to 120 square inches of film if it is developed *all at one time*. (Not several films in succession.)

C. Develop 100% longer than the times given for the concentrated developer, as indicated in the table.

D. Finer grain is obtained with no loss of emulsion speed if ½ gram (7½ grains) of potassium thiocyanate is added to each liter (quart) of diluted developer. Since such a small amount is hard to weigh accurately it is best to make up a 5% stock solution of thiocyanate (5 grams in 100 cc of solution or 1 oz. in 20 fluid oz.). Then the 10 cc (3 drams) which contains ½ gram of thiocyanate can easily be measured with a burette or small graduate (see Chap. VI).



"Doctor's Orders" *Rowena Fruth*

"The first roll of film I ever exposed I developed in Edwal-20 and I still use it for all my miniature work."

Rowena Fruth.

This method requires very efficient agitation to obtain brilliant negatives. Hence with certain types of cut film tanks and with the very small roll film tanks where developer circulation is rather poor a 7:1 dilution (or in extreme cases 6:1) should be used to obtain full contrast. Since a gelatin emulsion swells much more in a diluted developer than in a concentrated one, Thermo-Salt (one measure per pint) should be used in hot weather development to prevent gelatin swelling, whether the developer is maintained below 70° F. or not. Otherwise the swelled emulsion may reticulate if subsequent solutions are at different temperatures, or even if transferred from cool wash water to a warm atmosphere for drying.

DEVELOPING TIME TABLES FOR EDWAL-20 AND SUPER-20

Where no times are given in the table, development under those conditions is not recommended.

Developer (and its condition)	Method of use	Temperature °F	Temperature °C	Developing Times, In Minutes (By Film Classes) *Times for developers containing Thermo-Salt are printed in bold face type. I	*	II	*	III	*	IV	*	V	*	VI	*	VII	*
Edwal-20 (fresh or High Energy Replenished) *Super-20* (fresh or High Energy Replenished)	Regular or Low Energy Replenishment Method (1st film only) or *every* film by High Energy Replenishment.	65	18	12	15	15	18	18	22	22	26	26	31	31	37	37	44
		70	21	10	12	12	15	15	18	18	22	22	26	26	31	31	37
		75	24	8	10	10	12	12	15	15	18	18	22	22	26	26	31
		80	27	—	8	—	10	—	12	—	15	—	18	—	22	—	26
		85	30	—	6	—	8	—	10	—	12	—	15	—	18	—	22
Edwal-20 (used) *Super-20* (used)	Regular** or Low Energy Replenishment Method (film *after* the first)	65	18	15	18	18	22	22	26	26	31	31	37	37	44	44	52
		70	21	12	15	15	18	18	22	22	26	26	31	31	37	37	44
		75	24	10	12	12	15	15	18	18	22	22	26	26	31	31	37
		80	27	—	10	—	12	—	15	—	18	—	22	—	26	—	31
		85	30	—	8	—	10	—	12	—	15	—	18	—	22	—	26
Edwal-20 (fresh) *Super-20* (fresh)	Dilution Method (every film)	65	18	24	30	30	36	—	44	—	52	—	62	—	74	—	88
		70	21	20	24	24	30	30	36	—	44	—	52	—	62	—	74
		75	24	16	20	20	24	24	30	30	36	—	44	—	52	—	62
		80	27	—	16	—	20	—	24	—	30	—	36	—	44	—	52
		85	30	—	12	—	16	—	20	—	24	—	30	—	36	—	44

**When used by the *Regular Method* the developing times should be increased 10% for each roll of 35 mm. film (60 sq. in.) or equivalent area of other film after the 7th roll has been developed in one quart. Maximum life: 15 to 18 rolls per quart if used up in 3 to 4 weeks. If stored for long periods or if exposed to air a great deal, maximum life is 10 to 12 rolls per quart and the 10% increase should be started after the 5th roll instead of the 7th.

EDWAL-20

	Metric	*U. S. Units*
Water (distilled)	**900 cc**	**30 ounces**
Gradol	**5 grams**	**75 grains**
Fine Grain Sulphite	**90 grams**	**3 ounces**
Diamine-P	**10 grams**	**150 grains**
Monazol	**5 grams**	**75 grains**
Water to make	**1 liter**	**1 quart**

(Available in prepared form)

Edwal-20 is intended for the production of negatives which can be enlarged to 25 diameters or more. With care in processing negatives can be produced which are capable of enlargement to 60 diameters without objectionable grain.

Edwal-20 is intended for use with full normal exposure on 35 mm film, 50% more than normal on larger rolls or packs, and twice normal on cut film and plates. Edwal-20 produces a yellowish brown silver deposit and negatives should appear rather thin on visual inspection. Suggested life: 10 to 12 rolls of 35 mm or 2¼ x 3¼ film per quart. (Maximum: 15 to 18 rolls if used within a few weeks.)

If stored for long periods or if exposed to air a great deal, the 10% increase should be started after the 5th roll instead of the 7th.

Edwal-20 can be used by the Replenishment Method or the Dilution Method just as with Edwal-12. However, in the Replenishment Method with Edwal-20, the developing time should be increased 10% after the 6th roll and an additional 10% after the 9th roll (which amounts to putting the film in the next higher developing class). After the 9th roll no further increase of developing time is necessary.

If Edwal-20 is used by the Dilution Method, thiocyanate should not be added, because with any "super fine" grain developer, the use of thiocyanate causes a considerable increase in fog.

EDWAL-20 HIGH ENERGY REPLENISHER

Many photographers, especially those who use large negatives, prefer the snappy negatives produced by fresh Edwal-20 to the somewhat softer ones produced by used Edwal-20 or by Edwal-20 replenished by the method described for Edwal-12 (called the "low-energy" replenishing method to distinguish it from the "High-Energy" method described here). For such users a "High-Energy" replenisher has been worked out. The formula is:

EDWAL-20 HIGH ENERGY REPLENISHER

	Metric	*U. S. Units*
Water	**900 cc**	**30 ounces**
Gradol	**4 grams**	**60 grains**
Metol	**2 grams**	**30 grains**
Fine Grain Sulphite	**90 grams**	**3 ounces**
Diamine-P	**10 grams**	**150 grains**
Monazol	**5 grams**	**75 grains**
Water to make	**1 liter**	**1 quart**

(Available in prepared form)

After a 35 mm roll (or 60 square inches of any film) is developed in fresh Edwal-20, replace 2 ounces of used Edwal-20 with 2 ounces of the above replenisher solution. Pour the 2 ounces of replenisher into the Edwal-20 storage bottle while the film is in the developer, and when development is finished, pour in the used developer from the tank until the bottle is full, discarding any used developer remaining in the tank. This restores the original full energy so that the next roll is developed for the same length of time (if of the same film class). The table on page 36 gives the developing times for fresh Edwal-20 and for Edwal-20 used with "High-Energy" Replenisher.

Replenishment with the High Energy Replenisher may be carried on until 2 quarts of replenisher have been used up for each quart of fresh Edwal-20 originally used. The developer should then be discarded and a fresh batch of Edwal-20 made up. The high energy replenishing method allows the use of less exposure than the low energy method but does not give as fine grain.

EDWAL-32

A non-staining super-fine grain developer.

	Metric	*U. S. Units*
Water	**900 cc**	**30 ounces**
Metol	**12 grams**	**180 grains**
Fine Grain Sulphite	**90 grams**	**3 ounces**
Orthamine	**12 grams**	**180 grains**
Sodium Bisulphite	**10 grams**	**150 grains**
Water to make	**1 liter**	**1 quart**

This developer is softer working than Edwal-20. Edwal-20 will give more pleasing results on subjects where there are no violent contrasts and

for general photography in northern United States. Edwal-32 is better for subjects having strong contrast and for general outdoor work in the Southern States and tropical regions.

DEVELOPING TIMES IN MINUTES FOR EDWAL-32

Temperature	Class I	Class II	Class III	Class IV	Class V	Class VI	Class VII
65° F (18°C)	11	13	16	20	24	30	36
70° F. (21°C)	9	11	13	16	20	25	30
For 75° or above add one measure of Edwal Thermo-Salt per pint and develop:							
75° F. (24°C)	9	11	13	16	20	25	30
80° F. (27°C)	7	9	11	13	16	20	25
85° F. (30°C)	6	7	9	11	13	16	20

These times are for the *first* film. One quart will develop 15 rolls satisfactorily if protected from air. To determine the developing time for the second and subsequent rolls multiply the times given in the table by the following factors: 1.06 (for 2nd roll); 1.13 (for 3rd roll); 1.19; 1.25; 1.31; 1.38; 1.44; 1.5; 1.56; 1.62; 1.7; 1.8; 1.9; 2.

EDWAL MINICOL

Especially designed for flash photography

Minicol is a prepared developer having properties somewhat similar to Edwal-32. Minicol, however, gives finer grain on the medium speed fine grain film than any developer we have ever tested. When used with films such as Finopan, Panatomic, Panatomic-X, and Plus-X it is the ideal developer for the tourist and the vacationist who does not want to worry about fussy procedure but wants a good picture every time. It is also recommended for flash photography and all strongly lighted close-up shots of flowers, insects, machinery, men's portraits, etc., wherever surface texture must be shown. Minicol is sold in prepared form only.

Since Minicol produces extremely fine grain and is designed to bring out texture and to render contrasty subjects (*e.g.*, photo flash pictures) without blocking up of highlights, it should also be used for brilliant summer sunlight shots (especially close ups and portraits). Exposure should be normal for miniature negatives, and 1½ to 2 times normal for larger negatives for contact printing. When extra contrast is needed, 20% extra development is suggested as it will not block highlights or seriously increase grain.

DEVELOPING TIMES IN MINUTES FOR MINICOL AT 65° F.

*For developing 60 square-inch-area films (such as 36 exp. 35 mm or 120 size) in a quart of Minicol, use the times given below.

Film Class	(Consult classification at end of chapter) I	II	III	IV	V	VI	VII	VIII
1st Film----	7	8	10	12	14	16	20	26
2nd Film----	7½	8½	10½	12½	15	17	21	27
3rd Film----	8	9	11	13	16	18	22	28
4th Film----	8½	9½	11½	13½	17	19	23	29
5th Film----	9	10	12	14	18	20	24	30
6th Film----	9½	10½	12½	15	19	21	25	32
7th Film----	10	11	13	16	20	22	26	34
8th Film----	10½	11½	14	17	21	23	27	36
9th Film----	11	12	15	18	22	25	29	39
10th Film----	12	13	16	20	23	27	31	42

*NOTE:
When developing 60 sq. in. rolls in a *pint* of Minicol, use the times in alternate lines (1st, 3rd, 5th, etc.) for successive rolls. Developing times for other areas of film in various volumes of Minicol may be calculated from the above table since each increase in developing time shown here is for each 60 sq. in. of film per quart of Minicol. For instance: when developing 4 x 5 inch cut films in a half-gallon tank of Minicol, use the time in *successive* lines (1st, 2nd, 3rd, etc.) for each successive half-dozen films developed at one time, or the times in *alternate* lines (1st, 3rd, 5th, etc.) for each successive batch of a full dozen.

Although the *finest* grain and *softest* contrast is obtained by using Minicol at 65° F., this developer may be used when necessary at higher temperatures if Edwal Thermo-Salt is added. The usual proportionate increases for developers containing Thermo-Salt are not valid for Minicol containing Thermo-Salt and the times given in the tables below should be followed. At temperatures of 75° or above, a good chrome hardener (such as Edwal 291, *page 10*) should be used before fixation.

Minicol should be used in thoroughly cleaned stainless steel or plastic tanks since small amounts of Paraphenylenediamine, tin, copper, or brass will cause fog and coarse grain.

After developing, rinse in neutral water (city water plus a few drops of Acetic Acid) and fix in an acid-hardening fixer such as Edwal Liquid-Fix or Quick-Fix. Wash 30 minutes in running water, and hang in a dust-free place to dry.

DEVELOPING TIMES IN MINUTES FOR MINICOL *CONTAINING EDWAL THERMO-SALT*

(For developing 60 sq. in. area films in a QUART)
See "NOTE" page 40 for other film areas.

Film Class	Temp. °F	1st Film	2nd Film	3rd Film	4th Film	5th Film	6th Film	7th Film	8th Film	9th Film	10th Film
I	65°	9	9½	10	10½	11	11½	12	12½	13	14
	70	8	8½	9	9½	10	10½	11	11½	12	13
	75	6½	7	7½	8	8½	9	9½	10	10½	11½
	80	5½	6	6½	7	7½	8	8½	9	9½	10½
	85	4½	5	5½	6	6½	7	7½	8	8½	9½
II	65	10½	11	11½	12	12½	13	13½	14	14½	15½
	70	9	9½	10	10½	11	11½	12	12½	13	14
	75	7½	8	8½	9	9½	10	10½	11	11½	12½
	80	6½	7	7½	8	8½	9	9½	10	10½	11½
	85	5½	6	6½	7	7½	8	8½	9	9½	10½
III	65	13	13½	14	14½	15	15½	16	17	18	19
	70	11	11½	12	12½	13	13½	14	15	16	17
	75	9½	10	10½	11	11½	12	12½	13½	14½	15½
	80	8	8½	9	9½	10	10½	11	12	13	14
	85	7	7½	8	8½	9	9½	10	11	12	13
IV	65	15½	16	16½	17	17½	18½	19½	20½	21½	23½
	70	13	13½	14	14½	15	16	17	18	19	21
	75	11½	12	12½	13	13½	14½	15½	16½	17½	19½
	80	9½	10	10½	11	11½	12½	13½	14½	15½	17½
	85	8	8½	9	9½	10	11	12	13	14	16
V	65	18	19	20	21	22	23	24	25	26	27
	70	15	16	17	18	19	20	21	22	23	24
	75	13	14	15	16	17	18	19	20	21	22
	80	11	12	13	14	15	16	17	18	19	20
	85	9½	10½	11½	12½	13½	14½	15½	16½	17½	18½
VI	65	21	22	23	24	25	26	27	28	30	32
	70	17	18	19	20	21	22	23	24	26	28
	75	15	16	17	18	19	20	21	22	24	26
	80	12½	13½	14½	15½	16½	17½	18½	19½	21½	23½
	85	11	12	13	14	15	16	17	18	20	22
VII	65	26	27	28	29	30	31	32	33	35	37
	70	22	23	24	25	26	27	28	29	31	33
	75	19	20	21	22	23	24	25	26	28	30
	80	16	17	18	19	20	21	22	23	25	27
	85	13½	14½	15½	16½	17½	18½	19½	20½	22½	24½
VIII	65	34	35	36	37	38	40	42	44	47	50
	70	28	29	30	31	32	34	36	38	41	44
	75	24	25	26	27	28	30	32	34	37	40
	80	20	21	22	23	24	26	28	30	33	36
	85	17	18	19	20	21	23	25	27	30	33

"Summertime" *Edmund W. Lowe*

Taken on Plus-X film developed in Minicol. Print developed in Edwal-111. Minicol is recommended for summertime photography where brilliant light is encountered.

EDWAL-36

A non-staining stock-solution-type fine grain developer.

	Metric	*U. S. Units*
Water	**400 cc**	**13 ounces**
Fine Grain Sulphite	**50 grams**	**1-2/3 ounces**
Edwal C. H. Q.	**25 grams**	**375 grains**
Edwal T. S. P.	**9 grams**	**135 grains**
Potassium Thiocyanate	**5 grams**	**75 grains**
Water to make	**500 cc**	**1 pint**

To Use: Dilute 1 part of stock solution with 9 parts of 10% sodium sulphite solution. Use for 1 or 2 rolls and then discard. A 10% sodium sulphite solution contains 3-1/3 ounces of Edwal Fine Grain Sulphite in 1 quart of water.

Edwal-36 produces negatives capable of enlargement to about 15 diameters on fast films, and somewhat more on the fine grain films.

The grain is slightly finer if 11 cc (3 drams) of commercial (90%) Triethanolamine is used in place of T. S. P.

DEVELOPING TIMES IN MINUTES FOR EDWAL-36

Temperature	Class I	Class II	Class III	Class IV	Class V	Class VI	Class VII
65° F. (18°C)	7	8	9	11	13	16	20
70° F. (21°C)	6	7	8	10	12	14	16
75° F. (24°C)	5	6	7	9	10	12	14
For development above 75° add one measure of Edwal Thermo-Salt per pint and develop:							
75° F. (24°C)	6	7	8	10	12	14	16
80° F. (27°C)	5	6	7	9	10	12	14
85° F. (30°C)	4	5	6	8	9	10	12

These developing times are for soft negatives. For full contrast, the times given for Edwal-10 should be used for development in Edwal-36.

EDWAL THERMO-FINE

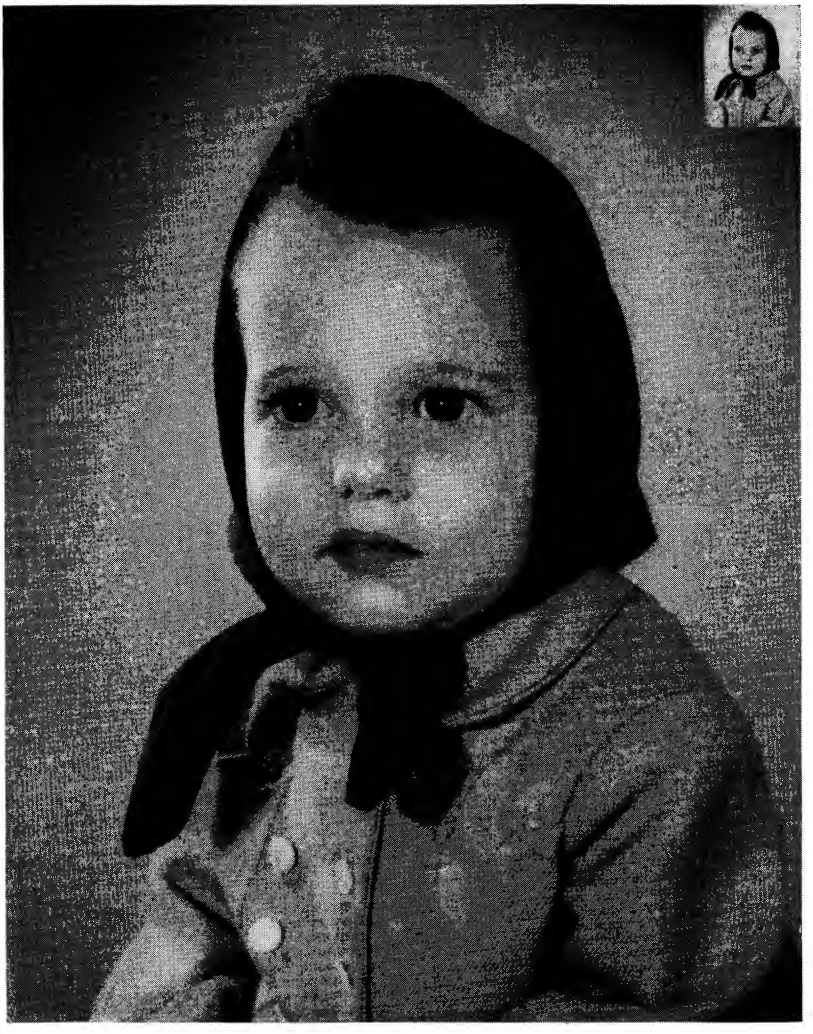
Thermo-Fine is a low priced fine grain developer designed for use by the beginner, the occasional photographer, and others who need fine grain similar to that produced by Edwal-12 but do not need the high emulsion speed produced by the latter developer. It is sold in tube form, is non-staining, and since it contains Thermo-Salt it can be used over a wide range of temperature. It requires no stop bath at normal temperatures since the chemicals in it will not harm any acid-fixer.

Thermo-Fine is a prepared powder developer, and complete directions for dissolving the powders are printed on the label of each tube. Distilled water is recommended, but any reasonably pure water can be used. The solution should always be cooled to 70° F. and allowed to stand a while (over night if possible) after completely dissolving the powders. Any solid matter present in the solution at that temperature should be filtered out and thrown away before the developer is used to develop film.

If the developer is cooled below 65°, crystals may form. If this occurs, the mixture should be warmed and stirred till the crystals redissolve. Occasionally crystals will form on long standing even though the developer is not cooled below 65° F. Such crystals may be filtered out and thrown away without harm to the developer.

How to Use Thermo-Fine:

When the film is placed in the developing tank, the Thermo-Fine solution is poured in, the temperature is measured, and the film is allowed to develop for the time specified in the tables below for that particular



William Kallir

William Kallir, famed New York child portraitist, uses miniature negatives developed in Edwal-12—with prints done in Edwal-111.

film and temperature. Mechanical agitation or vigorous manual agitation every 1 or 2 minutes is recommended. If less agitation is used, the developing time may have to be prolonged about 10% to obtain proper contrast.

If the temperature is below 75° the film may be transferred directly to a good acid-hardening fixer. If high speed is desired, Edwal Quick-Fix should be used. If speed is not a factor, Edwal Acid Fix or Edwal Liquid-Fix will be satisfactory. The fixing time in Quick-Fix is about 3 minutes and in Acid Fix or Liquid-Fix, 10 to 15 minutes.

If the temperature is 75° or above, the film should be hardened in a good chrome alum bath, such as Edwal Chrome Hardener, between developing and fixing.

Developing Time

Photographers often want different degrees of contrast in the negative, depending on the scene they are photographing. Since contrast is governed by developing time, three tables of developing times are given here. Table A is for use in developing film which has been exposed in brilliant summer sunlight or under other conditions where shadows in the scene are very dark and high lights are very bright (these being the conditions most often encountered by the beginner or the occasional photographer).

TABLE A (for film exposed on "contrasty" subjects)

Developing time in minutes for the first roll of film in a quart of Thermo-Fine.

Film Class	I	II	III	IV	V	VI	VII
65° F. (18° C.)----	7	8	10	12	15	18	22
70° F. (21° C.)----	6	7	8	10	12	15	18
75° F. (24° C.)----	5	6	7	8	10	12	15
80° F. (27° C.)----	4	5	6	7	8	10	12
85° F. (30° C.)----	3½	4	5	6	7	8	10
90° F. (33° C.)----	3	3½	4	5	6	7	8

After the first film has been developed, the time for subsequent films should be increased 5% for each roll developed in a quart or 10% for each roll developed in a pint of Thermo-Fine.

Table B is for use with subjects of "average" contrast, e.g. outdoor scenes in spring or autumn, distant scenes where no deep shadows can be found, average indoor shots, etc.

TABLE B (for average lighting)

Developing time in minutes for the first roll of film in a quart of Thermo-Fine.

Film Class	I	II	III	IV	V	VI	VII
65° F. (18° C.)----	8	10	12	15	18	22	28
70° F. (21° C.)----	7	8	10	12	15	18	22
75° F. (24° C.)----	6	7	8	10	12	15	18
80° F. (27° C.)----	5	6	7	8	10	12	15
85° F. (30° C.)----	4	5	6	7	8	10	12
90° F. (33° C.)----	3½	4	5	6	7	8	10

After the first film has been developed, the time for subsequent films should be increased 5% for each roll developed in a quart or 10% for each roll developed in a pint of Thermo-Fine.

Table C is for use in developing film exposed on dull, hazy, or rainy days, or in weak winter sunlight, or under any conditions where the illumination is very even and no strong shadows are present. (In case pictures made under several different kinds of lighting are on the same film, the entire roll should be developed according to the time which would be recommended for the softest lighting that was encountered.)

TABLE C (for film exposed under dull or flat lighting)

Developing time in minutes for the first roll of film in a quart of Thermo-Fine.

Film Class	I	II	III	IV	V	VI	VII
65° F. (18° C.)----	10	12	15	18	22	28	34
70° F. (21° C.)----	8	10	12	15	18	22	28
75° F. (24° C.)----	7	8	10	12	15	18	22
80° F. (27° C.)----	6	7	8	10	12	15	18
85° F. (30° C.)----	5	6	7	8	10	12	15
90° F. (33° C.)----	4	5	6	7	8	10	12

After the first film has been developed, the time for subsequent films should be increased 5% for each roll developed in a quart or 10% for each roll developed in a pint of Thermo-Fine.

How Long Will Thermo-Fine Last?

Thermo-Fine will keep indefinitely in powder form at ordinary temperatures. The solution can be stored for many months without loss of strength if kept in tightly sealed bottles that are full to the neck. The keeping qualities can be further improved if the water is boiled for 10 to 20 minutes to drive off oxygen and other dissolved gases just before the developer powders are dissolved.

Like all developers Thermo-Fine loses strength through oxidation by air and hence it is not recommended that the solution be stored for long periods after it has developed several rolls of film. Ten rolls of film can safely be developed in a quart if done in one or two days (in laboratory tests more have been developed), but if the developer is used intermittently its life should be limited to 6 or 8 rolls. The price of Thermo-Fine has purposely been kept low so that it is not necessary to force the developer to its limit.

MICROGRAIN-85

An established fine-grain developer (formerly produced by Mansfield) combining physical and chemical action in producing negatives from full normal exposures with contrast similar to that of Edwal-12, but having slightly finer grain.

A special developing-time table is furnished with each package of Micrograin-85. These developing times are being checked and revised to conform with the standard Edwal Film Classification, and when complete, this data will be included with future packages, and in future editions of this book.

CLASSIFICATION OF FILMS FOR EDWAL DEVELOPERS

The various films have been divided into classes and the developing times given are designed to produce rather soft negatives suitable for enlarging purposes (a gamma of about .7 to .8). However, on larger roll films and packs, somewhat stronger contrast is sometimes desired. Where this is the case the developing times given should be increased about 10%.

A number of films included in the list are not ordinarily developed in fine grain developers. However, they can be so developed if desired and will give rather soft negatives with the developing times suggested. Contrast can always be varied up or down by increasing or decreasing the developing time.

FILM CLASSIFICATION FOR ALL EDWAL DEVELOPERS (EXCEPT MINICOL AND MICROGRAIN-85)

35 MM FILMS AND SMALLER

AGFA ANSCO: Finopan IV, Positive III, Infra-Red III, Supreme IV, Ultra Speed V.

DuPONT: Infra-D IV, Superior No. 1 II, Superior No. 2 IV, Superior No. 3 VI, Microcopy I.

EASTMAN: Microfile III, Infra-Red III, Panatomic-X IV, Plus-X V, Super XX VI, Positive IV.

GEVAERT: Panchromosa 32 VII, Pan. Microgran 27 VI.

ILFORD: Selochrome Special Fine Grain IV, Selo Extra Fine Grain Panchromatic (FP2) IV, Selo Hypersensitive Fine Grain Panchromatic (HP2) VI, Selo Infra-Red VI.

MINOX: A (100-W) III, B (50-W) II, C (24-W) II.

UNIVEX: Ultra Pan IV.

ROLL FILMS AND PACKS

NOTE: Packs should be developed 10% longer than the corresponding roll film because of their scratch-proof coating.

AGFA ANSCO: Finopan V, Plenachrome IV, Super Plenachrome V, Superpan Supreme V, Superpan Press V, Infra-Red III.

EASTMAN: N.C. V, Panatomic-X IV, Verichrome V, Super XX V, Plus-X V, Super Ortho Press V, Infra-Red III.

GEVAERT: Superchrome IV.

ILFORD: Selochrome I, Selo FP I, Selo HP3 IV.

SHEET FILMS AND PLATES

AGFA ANSCO: Commercial V, Commercial Ortho V, Commercial Panchromatic IV, Isopan VI, Superpan Portrait VII, Supersensitive Panchromatic V, Supersensitive Plenachrome VII, Superpan Press VI, Super Plenachrome Press VI, Triple S Pan VII, Triple S Ortho VI.

DEFENDER: XF Pan VII, F.G. Pan IV, XF Ortho VI, Portrait VII, Pentagon V, Commercial IV, Arrow Pan V, Arrow Pan Press V, Ortho-7 VII plus 100%.

EASTMAN SHEET FILM: Super Speed Ortho Portrait VII, Panatomic-X V, Commercial IV, Portrait Pan V, Super XX VI, Tri-X VII, Ortho-X VII, Super Ortho Press IV, Super Panchro Press Sports Type VII, Super Panchro Press, Type B VI, Infra Red IV.

EASTMAN PLATES: Eastman 33 IV, Eastman 40 VII, Eastman 50 VI, Polychrome V, Commercial IV, Wratten Panchromatic III, Super Panchro Press VI, Super Ortho Press IV, Tri-X Pan, Type B, VII.

GEVAERT: Superchrome VIII, Ultra Panchro VI.

HAMMER: Commercial Pan IV, Medium Commercial III, Medium Commercial Ortho III, Portrait Ortho V.

ILFORD FLAT FILMS: HP2 I, Portrait Pan III, Hyperchromatic III, Commercial Ortho I, Fine Grain Ordinary I, Selechrome II.

ILFORD PLATES: HP2 I, Hypersensitive Pan (H. P. 3) II, XX Press II. Selochrome I, Golden Iso Zenith IV, SG Pan III, SR Pan I, Press (Ortho) I. Iso Zenith III, F. G. Ordinary I, Eclipse-Ortho I, F. P. 3 I.

FILM CLASSIFICATION
FOR DEVELOPING IN MINICOL (ONLY)

35 MM FILMS AND SMALLER

AGFA ANSCO: Finopan VI, F.G. Plenachrome IV, Infra-Red IV, Supreme VI, Ultra-Speed VIII.
DuPONT: Microcopy I, Infra-D VI, Superior No. 1 III, Superior No. 2 VI, Superior No. 3 VIII.
EASTMAN: Panatomic-X V, Plus-X VI, Super XX VIII, Infra-Red VI.
GEVAERT: Panchromosa 32 VIII, Pan. Microgran 27 VII.
ILFORD: Selochrome Special Fine Grain V, Selo Extra Fine Grain Panchromatic (FP2) V, Selo Hypersensitive Fine Grain Panchromatic (HP2) VIII, Selo Infra-Red VII.
MINOX: A IV, B III, C III.
UNIVEX: Ultra Pan V.

ROLL FILM

AGFA ANSCO: Finopan VII, Plenachrome VIII, Superpan Supreme VIII, Superpan Press VIII, Super Plenachrome VIII.
EASTMAN: N.C. VIII, Verichrome VIII, Panatomic-X VII, Super XX VIII, Plus-X VI, Super Ortho-Press VI.
GEVAERT: Superchrome V.
ILFORD: Selochrome II, Selo FP II, Selo HP3 V.

Packs should be developed 10% longer than the corresponding roll film. The class number for *Cut Film* to be developed in Minicol may be determined by adding I to the class number of the film shown for other Edwal developers.

These classifications are up to date as of March 1, 1947. As new emulsions are marketed or changes are made in others, the classification is changed accordingly. If this table is more than a year old, the latest revised film classification can be obtained on request from The Edwal Laboratories, Inc., 732 Federal St., Chicago 5, Illinois.

SPECIAL NOTE: The War Surplus Films now being distributed under various labels vary from lot to lot, and cannot be identified as to original brand. A definite classification, therefore, cannot be given. It is recommended that such films be developed in CLASS V as a compromise, varying the time on later rolls, but recognizing that later rolls may not be of the same original brand.

HOT WEATHER DEVELOPMENT

It will be noted that developing times from 75° F. up are given with each developer and that mention is often made of the addition of Edwal Thermo-Salt.

Thermo-Salt is a pure, photographically inert chemical which greatly slows up the swelling of the gelatin used in film and paper emulsions. The usual photographic solutions unless they contain Thermo-Salt are quite dilute, and particularly when warm (over 70° F.), will rapidly swell gelatin, which is then soft and subject to scratches and *reticulation.*

Because Thermo-Salt keeps the gelatin from swelling, it slightly retards the penetration of the developer, and makes necessary a 20% longer developing time at any particular temperature than when Thermo-Salt is not used. However, shorter developing times are needed at higher temperatures which offset the increase needed due to Thermo-Salt. Only one treatment of a solution with Thermo-Salt is necessary, but if a replenishing developer is used, Thermo-Salt must be used in the replenisher to keep up its concentration in the developer. To retain the

effectiveness of Thermo-Salt ALL solutions preceding the fixer must also be treated with Thermo-Salt.

If Thermo-Salt is added for hot weather processing, it will not prevent later use of the solution at cooler times, although the 20% longer development must be maintained in calculating developing times.

How to Use Thermo-Salt

A small measuring cup is included in each package of Edwal Thermo-Salt. This cup, when level-full, contains enough Thermo-Salt for one pint of developer. Add Thermo-Salt slowly to the developing solution, meanwhile stirring vigorously. After the Thermo-Salt is completely dissolved, the developer is ready for use. If the developer is a stock solution which is to be diluted for use, add one measure level full of the Thermo-Salt to each pint of the *working solution*—not to the stock solution. Use Thermo-Salt also in Short Stop or Hardener, but *not* in the Fixer. One pound of Thermo-Salt will treat 18 pints of solution.

Developing Times When Using Thermo-Salt

It is common practice to *decrease* film developing times 20% for each 5° F. *increase* in temperature because of the greater activity of developing agents as they get warmer.

Using this proportion, determine the developing time (to the nearest minute) for your developer at its present temperature, and then add 20% to that time to take care of the slowing effect of Thermo-Salt. For example: for Plus X Film (or any other Edwal Class V Film) to be developed in Edwal Super-12, the times would be as shown below.

Temperature	Without Thermo-Salt	With Thermo-Salt
65° F.	22 Minutes	26 Minutes
70° F.	18 Minutes	22 Minutes
75° F.	15 Minutes	18 Minutes
80° F.	*	15 Minutes
85° F.	*	12 Minutes
90° F.	*	10 Minutes

*Development at these temperatures without Thermo-Salt is NOT recommended.

Fine Grain Developers: Fine Grain Developers containing Thermo-Salt can be used at any temperature up to 90° F., if desired.

Ordinary Film Developers: Thermo-Salt may be used to advantage with ordinary Metol-Hydroquinone or similar developers. However, tray development in strongly alkaline solutions above 85° F. is not recommended, and developing solutions containing sodium hydroxide (caustic soda) should *never* be used above 70° F.

Thermo-Salt in the Rinse Bath: With any developer containing large quantities of sulphite or carbonate, film should be rinsed for 2 to 4

minutes between developing and fixing in a solution containing 5 to 10 drops of 28% acetic acid and one measuring cup full of Thermo-Salt per pint of water. This prevents pinholes or blisters which might be formed due to the action of a strong acid hypo or hardening bath on the carbonate carried over in the emulsion. If the same rinse bath is to be used repeatedly, a few drops of acetic acid should be added after every third roll.

Thermo-Salt should also be added to the acid Short Stop customarily used after ordinary film developers.

Thermo-Salt in a Hardener: If a hardener, such as a Chrome Hardener, is used for a film developed in a Thermo-Salt treated solution, one scoop of Thermo-Salt should also be used in each pint of hardener. It is *not* needed in the fixer. If such a hardener is used, the rinse bath mentioned above (for developers containing a lot of sulphite or carbonate) may be omitted and the film transferred directly from the Thermo-Salt treated developer to a Thermo-Salt treated hardener.

THE EDWAL PREPARED DEVELOPERS

The eight developers, Edwal 10, 12, 20, 32, 36, Minicol, Thermo-Fine and Micrograin-85 will enable the photographer to get practically any effect desired. Of these eight, three are by far the most popular—Edwal-12, for fine-grain speed work, Edwal-20 for general super fine grain developing, and Minicol for flash photography or exposures in brilliant light. These three are at present sold in prepared form, both powder and liquid. Sizes, prices, etc., will be found in the last pages of this book.

The aim has been to make these developers available to those with whom photography is strictly a hobby and who wish to get good pictures without too great an accumulation of weighing, measuring, mixing and other apparatus. The powdered developers are low-priced and convenient, but unless distilled or other pure water is available for mixing, the liquid developers are to be preferred. These are made from pure chemicals, dissolved in distilled water, mixed and handled in stainless steel apparatus, and marketed in bottles whose glass has been tested to be sure that it will not give off alkali to the solution during storage. In short, they are the best we know how to make and are ready for immediate use.

Non-Fine Grain Developers

The bulk of this chapter has been devoted to fine grain developers. However, if fine grain is not important, several of the developers given in Chapter V for prints will also produce excellent negatives. Accord-

"Tetons" *Edmund W. Lowe*

Agfa infra-red 35 mm film, developed in Edwal-12. Print developed in Edwal-111.

ingly instructions are given in Chapter V for use of these formulas for negative development both by tray and tank methods. The general technique of handling is the same as is described above for the fine grain developers.

Exposure and Grain

Too much exposure causes too rapid development with resulting coarse grain. The best exposure for fine grain work is the shortest exposure that produces sufficient shadow detail. Too short an exposure, however, gives negatives with poor printing quality. For this reason it is best to make several exposures of different lengths on each subject so that the final picture may be made from the thinnest negative that has the necessary printing quality.

The following American Scheiner ratings have been found by test to give low-density negatives with good printing quality with average scenes, and are recommended where only one shot can be made.

TABLE III
RECOMMENDED AMERICAN SCHEINER RATINGS

Film	Edwal-12, Edwal-10		Edwal-20, Edwal-32; Minicol	
	Day	Tung	Day	Tung
35 mm SPOOLS*				
Ultra-Speed Panchromatic	32	30	29	27
Superpan Supreme	29	27	26	24
Finopan	25	23	22	20
Superior 1	26	24	23	21
Superior 2	29	28	26	25
Superior 3	30	29	27	26
Microcopy	....	16	....	13
Kodak Super-XX	32	30	29	27
Kodak Plus-X	30	29	25	23
Kodak Panatomic-X	24	22	21	19
ROLL FILMS AND PACK FILMS*				
Superpan Press	32	31	29	28
Superpan Supreme	27	26	24	23
Finopan	25	23	22	20
Kodak Super-XX	32	30	29	27
Kodak Panatomic-X	26	24	23	21
Kodak Verichrome	29	27	26	24
Kodak Plus-X	29	27	26	24
SHEET FILM**				
Triple S Pan	32	30	29	27
Superpan Press	32	31	29	28
Isopan	28	27	25	24
Triple S Ortho	32	26	29	23
Arrow Pan	29	27	26	24
X-F Panchromatic	26	24	23	21
Fine Grain Panchromatic	23	21	20	18
Super Panchro-Press, Sports Type	32	31	29	28
Panatomic-X	23	21	20	18
Super-XX	29	27	26	24

*These ratings are intended for miniature negatives (up to 5 square inches in area) and are approximately ½ "normal" for Edwal-12 and "normal" for Edwal-20. For larger negatives 50% to 100% more exposure will be needed.

**These ratings are intended for larger negatives and are approximately "normal" for Edwal-12 and twice "normal" for Edwal-20.

Because several different systems of speed rating are used, a conversion table is given on the following page. Strictly speaking, it is impossible to convert from one system to another since film speeds are not determined in the same manner for all systems. However, the following table is accurate enough for practical purposes.

COMPARISON OF SPEED RATING SYSTEMS

A S A Exposure Index	General Electric	Weston	American Scheiner	A S A Exposure Index	General Electric	Weston	American Scheiner
6	8	5	14	64	80	50	24
8	10	6	15	80	100	64	25
10	12	8	16	100	125	80	26
12	16	10	17	125	150	100	27
16	20	12	18	160	200	125	28
20	24	16	19	200	250	160	29
25	32	20	20	250	300	200	30
32	40	24	21	320	400	250	31
40	48	32	22	400	500	320	32
50	64	40	23	500	600	400	33

On close-ups, the meter should be pointed at the darkest part of the subject where detail is desired. Roll films should be rated one step lower than the corresponding 35 mm. emulsion if somewhat greater density is desired on larger negatives.

Daylight ratings are for use in bright sunlight only. Before 10:00 A. M. or after 3:00 P. M. or on smoky, cloudy, or hazy days, the Mazda ratings should be used, because films are proportionately more sensitive to blue and violet light than are the exposure meters. Smoke, fog, and haze filter out much of the blue and violet from natural daylight, so that a lower speed rating is necessary.

Exposures based on the rating as given in the table above are less than normal for Edwal-12 and full normal or more for Edwal-20 and Minicol. For films not included in this list, use normal exposure at manufacturers speed rating for *miniature* negatives to be developed in Edwal-20 and one half normal exposure for miniature negatives to be developed in Edwal-12. For larger negatives (having a negative area of five square inches or larger) use full normal exposure for Edwal-12 and one and a half to twice normal exposure for Edwal-20, particularly if small enlargements or contact prints are desired. However, if great prints or mural displays are to be made from larger negatives, the exposure should be shortened in order to secure finest grain structure possible.

Film to be developed in Thermo-Fine, fresh Edwal-20, and Edwal-20 replenished by the "High Energy" method may be exposed according to speed ratings one step higher than the ratings given for use with Edwal-20, (the latter are intended for the used developer). With either Edwal-12 or Edwal-20 used by the low-energy replenishing method, the next lower speed rating should be used for all film after the 9th roll in a quart. The same applies to un-replenished Edwal-12 and Edwal-20 after the 6th roll per quart.

Chapter IV

PRACTICAL PRINT MAKING

The positive picture which is made from the negative is commonly called a print. The making of a print is a simple process which can be carried out with simple apparatus, and it is the purpose of this chapter to explain as clearly as possible the steps in making the positive picture, or print, from a suitable negative. These steps are as follows:

1. *Expose the photographic paper under a negative in an enlarger or contact printer, or a printing frame. This produces a latent image on the paper.*
2. *Immerse the exposed paper in the developer in order to make the latent image visible.*
3. *Rinse the picture in an acid stop bath to stop development.*
4. *Immerse the picture in a fixing bath to remove undeveloped silver salt, and make the image permanent.*
5. *Wash the picture for an hour in running water to remove the fixer and the dissolved silver salts as completely as possible.*
6. *Dry the picture between blotters or on a ferrotype plate.*

The process as outlined above is easy and can be successfully carried out by anyone. However, each of the steps can be carried out in a variety of ways, some of which are better than others. The following paragraphs give an exact description of the method which will give the best results where no special effects are desired. After the beginner has become skilled in the art, he will want to use special developers, special printing methods, etc., in order to create the exact effect he wants. These special developers and methods are discussed in Chapters V and VII.

Selecting the Paper

Most people like pictures which have a good range of tone, from practically pure white in the highlights to very deep blacks in the shadows. Such pictures are said to be "snappy", or to have good contrast. Since some negatives have more contrast than others, different grades of printing paper are made so that a "snappy" print can be made from a flat negative as well as from a contrasty one. The contact printing papers are made in four or five grades of contrast while some of the enlarging papers are made in only one or two grades. If the negative which is to be used has average or "normal" contrast, a "normal" printing paper is used. For making a print from a soft or flat negative a "contrasty" (No. 3 or No. 4 grade) printing paper is necessary; while if the negative has unusually strong contrast a "soft" (e.g. a No. 1 grade) printing paper is best.

Photographic printing papers are made in a variety of surfaces ranging from glossy (very smooth) to matte or very rough surfaced paper. The glossy papers are commonly used in commercial work or where an appearance of extreme contrast or "snappiness" is desired. Matte or rough surfaced papers are used for softer effects in pictorial work.

Selecting the Developer

The expert photographer who is familiar with the various developers and the effects they will produce may select his developer with considerable care, as described in Chapter V. However, for the beginner or the photographer who wants to stick to one print developer for all types of work, we recommend Edwal-111 because it gives true neutral black tones and can be made to give snappy looking prints on all types of paper. Different types of printing paper require different strengths of developing solution; hence, in the instructions given for the use of Edwal-111 in Chapter V, different dilutions for the stock solutions are prescribed for developing contact papers, fast enlarging papers and slow enlarging papers. Generally speaking, the more concentrated the working solution of the developer is made, the stronger will be the contrast in the print and vice versa.

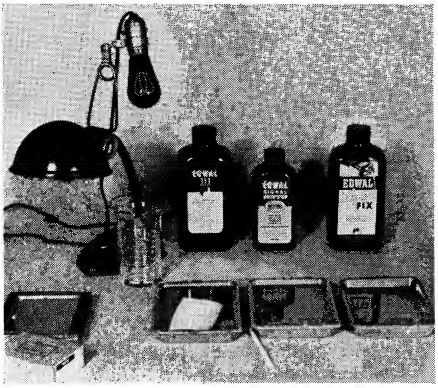


Fig 4 — EQUIPMENT FOR CONTACT PRINTING. For contact prints, the equipment need be only as shown: Contact printing paper, a printing frame, a white-light bulb (shown in a desk lamp), a safelight (the one shown is a plain amber bulb), a measuring-graduate, developer, shortstop, fixer, three trays and a thermometer

Darkroom Set Up

Amateur photographers frequently make prints without specially built or equipped darkrooms. A basement, a bathroom, a closet, or the kitchen suitably darkened by blocking out the windows are used successfully for print making by thousands of people. However, it should be remembered that even though printing paper can be handled under a fairly bright "safelight" which has a red or amber color, and which gives a light from which all the blue and green rays have been filtered out, this does not mean that the same paper can be handled successfully in very dim daylight, because such daylight has a certain percentage of blue light in it which will cause fogging of the paper, even though it is relatively dim.

Hence, all openings where daylight can get in should be scrupulously plugged up if good clean prints are desired. This is especially true when handling the fast enlarging papers.

The equipment of the darkroom need not be very elaborate. It is only necessary to have a printing device (an enlarger, or a contact printing box, or a printing frame), a tray to hold the developer, another tray to hold the acid-shortstop, and a third tray for the fixer. (See Fig. 4.) Usually the prints are washed after fixing in a print washing device which is so designed that water flows through it in a turbulent fashion, which causes the prints to be vigorously agitated during the washing process. Prints can, however, be successfully washed in a tray or a sink, or a bucket, or any other container which is so arranged that water circulates through it vigorously enough to keep the prints in motion during washing.

Usually an amber safelight is hung so that its rays fall on the developing tray so that development can be watched. Some sort of a timing device which will measure time in seconds is used for timing exposures and for measuring the length of immersion in the various solutions. Another very useful piece of equipment is a pair or two of print tongs for transferring prints from one solution to the other. A pair of scissors will also be found useful for cutting test strips and many other odd jobs. This apparatus is about all that is really needed for the simple darkroom operations. There are a great many gadgets which contribute to the pleasure and efficiency of darkroom work, but these will not be discussed here since they are fully described in manufacturers' literature which is available at any camera store.

Exposing a Contact Print

A contact print is made by placing the printing paper with its emulsion side in direct contact with the emulsion side of a negative, and exposing it to light whose rays are allowed to pass through the negative and strike the paper emulsion. This may be accomplished either in a printing frame or in a contact printing box as shown in the accompanying illustration. (Fig. 5.) If a printing frame is used, the negative and paper are placed in it and it is ex-

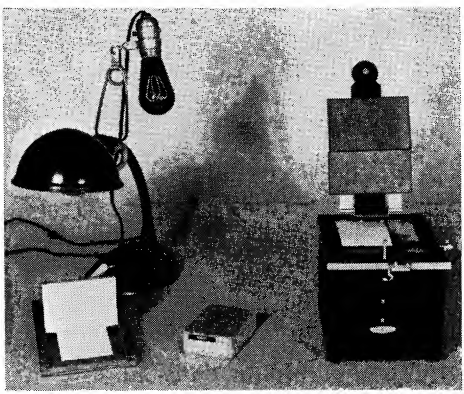


Fig. 5—Shows the placing of contact paper in a print-frame and in a contact print-box (alternative equipment) under an amber safelight.

posed for a measured length of time under an incandescent bulb or other source of white light. (Fig. 6.) During this process, of course, all sensitive photographic paper must be kept under cover except the piece in the printing frame. If a printing box is used, the source of light is enclosed so that there is very little, if any, leakage of light into the darkroom during exposure.

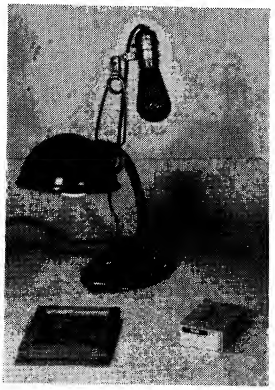


Fig. 6—Exposing a print in a contact print-frame. The white light from the desk lamp shines through the negative onto the printing paper.

It is customary to use a mask of paper or metal strips or "masking" bands to lay either on top of the negative or between the negatives and paper to mask off the outer edges of the negative and produce a print having a straight white border. If the print is later to be trimmed and mounted on a regular mounting board, this masking is usually not necessary, since the white border would be trimmed off anyway. It is necessary that the printing paper be held in firm contact with the negatives in the printing frame or in the contact printing box so as to get sharp definition and exact reproduction of the image.

Test Strips

Photo-electric exposure meters are sometimes used to measure the density of the negative and calculate the exposure time that will be necessary to produce a good print on the type of paper being used. However, in the absence of such a device, the common method of determining correct exposure time is to make a "test strip" which is a trial print different parts of which have been exposed for different lengths of time. When this test strip is developed, one of the sections will be found to have just the right degree of density and contrast. The exposure time that was used for that particular section is then considered to be the correct exposure time for use in making the final print.

If a printing frame is being used, the test strip can be easily made by putting a strip of photographic printing paper in contact with the negative in the printing frame and laying a piece of cardboard over it. The light is then turned on, and the piece of cardboard moved from one position to another across the printing frame in such a way that progressively shorter (or progressively longer) exposures are given different sections of the test strip. For instance, if the entire surface of the test strip was covered with the cardboard when the light was turned on, then successive

sections might be given exposures of 16 seconds, 12 seconds, 8 seconds, 6 seconds, 4 seconds, and 2 seconds. The strip is then developed, rinsed in the acid stop bath, and fixed for three or four minutes; and then inspected under white light to see which amount of exposure produced the best results.

If a printing box is used, it is hard to make a large number of different exposures on a single strip. In this case several small strips are separately exposed for different lengths of time, and then developed for a standard developing time, rinsed, and fixed and inspected to see which exposure was best. In making a test strip it is not necessary to use a full size sheet of printing paper. These sheets can be cut up into long strips which are placed across the negatives in such a way that the strip will be in contact with both a very dense section and a very thin section of the negative. The test strip should, of course, be fully developed (at least two minutes in Edwal-111) and after the correct exposure has been determined, the final print made on a full sheet of paper should be given *exactly the same exposure and developing time as the best section of the test strip.* After continuous practice the photographer can judge exposure time quite accurately from looking at the negatives, or by using an exposure meter. Even then, test strips should be made when starting on a new batch of paper or an unfamiliar developer, because emulsions vary and different developers sometimes require different exposures. It is good practice to cut up one sheet out of each batch of paper and use it for testing strips for that particular batch. Emulsions vary from batch to batch so that a test strip taken from one batch may not indicate the correct exposure for another batch of paper, even though it is the same brand.

Exposing an Enlargement

Exposing an enlargement is much the same as exposing a contact print except that the mechanical device for making the exposure is somewhat more complicated. An enlarger is usually built with a lamp house, a negative holder, and a set of lenses which will project the image from the negative onto the printing paper which is some distance away. By this means a larger image is produced on the printing paper than exists in the negative. The fundamental principles, however, are the same as for contact printing. The negative must be held between sheets of glass or in some other device which will keep it flat during the exposure, and it is placed in the negative holder with the emulsion side toward the printing paper. The paper is usually held in an easel or some other device which keeps it flat and which permits masking off the edges if white borders are desired.

The usual practice is to put the negative in the enlarger and put a sheet of non-photographic white paper on the easel, turn on the enlarger light and then focus the image on the white paper in the easel in such a way as to get the sharpest possible definition in the projected image. At the same time the easel is placed so that the outer edges of the negative image are properly masked off. In carrying out this focusing process, a very useful aid in getting extreme sharpness is an instrument such as the "See Sharp" focusing aid which can be obtained at camera stores at a very nominal price. After exact focus has been obtained, the enlarger light is turned out, and a piece of printing paper placed in the easel and a test strip made in much the same fashion as described above for contact printing. An opaque object is placed over the strip, the enlarger light is turned on and the opaque object moved across the test strip in such a way as to produce step-wise exposures for increasing lengths. For instance, succeeding areas on the strip might be given exposures of 10, 20, 30, 40 and 50 seconds. The strip is then developed, rinsed, and fixed and inspected to see which exposure produced the best result. This exposure is then used in making the final print.

Some enlargers are equipped with an orange safelight disc so that focusing can be done directly on the photographic paper itself. This safelight disc is a useful and time saving device, provided it lets enough light through to permit exact focusing.

Developing the Print

The developer itself is usually made up in concentrated form according to instructions given by the manufacturer or is purchased as a stock solution ready-mixed. It should be kept in small enough bottles so it will be used fast enough to empty a bottle within three or four weeks after the first portion has been taken out of it. Usually the small amount of air in the bottle will not greatly weaken the developing power of the solution, but it will frequently produce oxidation products which are dark in color, and which make the developer hard to see through when a print is being developed in it.

The working solution should be made by diluting the stock with water at the proper temperature just before the print making session is started. If possible, it is best to have the developer at a temperature fairly close to that of the room. If it is made up very much warmer or cooler than room temperature it will quite rapidly change to whatever the room temperature happens to be. All print developers work best at 65 to 70° F. Developers containing Metol or Amidol tend to produce yellow stains and give blocked-up shadow areas if used above 75°. The Monazol developer, Edwal-102, can be used up to 90° if necessary.

For development at 75° or above, Edwal Thermo-Salt should be added to the working solution (one measureful or approximately 25 grams per pint). This allows most developers (e.g. Edwal-111, 110, 126) to be used up to 85° F.

The print should be fully developed. Normal developing times are usually longer for enlarging papers than for contact papers, and longer for developers containing Monazol or C.H.Q. alone than for solutions containing Metol or Amidol. The best developing time is usually specified for each developer in directions given with the formula, or on the package. With Edwal-111, the richest black tones are obtained in development carried on for two to three minutes at 70°. If development is carried past 3½ minutes, with this developer or any other containing Metol, stains are apt to appear on the white portions of the print. The maximum developing time which can be used without staining decreases as the temperature of the solution is raised. However, the addition of Thermo-Salt to the developing solution restrains this tendency to staining and allows longer developing time at the high temperatures. No very exact rule can be laid out to predict what the maximum developing time will be at any given temperature because this depends to a considerable extent on variations in the emulsion and on the amount of use the developer has had. If it is necessary to develop at temperatures above 75°, it is best to determine the maximum developing time that may be used without staining by means of a test strip. In general, however, for most enlarging papers the maximum developing time that can be used without staining decreases about half a minute for each five degree rise in temperature with Metol developers.

When the print has been exposed it should be immediately inserted in the developer in such a way as to get complete immersion without delay. If it is merely dropped in, the middle may become wet first, causing the paper to curl so that the corners do not become wet with developing solution for 10 or 15 seconds afterwards. The print should be agitated vigorously for the first few seconds in the solution, and should be moved about occasionally thereafter. If possible, development should be watched without taking the print from the solution more than once or twice. Too much exposure to air may cause aerial fog, especially with developers which contain hydroquinone. Tendency to aerial fog is very slight with Edwal-111. If it is necessary to handle the prints by hand, the hands should be thoroughly washed before development to avoid fingermarks on the prints. Hands should also be washed every time a print is transferred from the developer to the shortstop or to the fixer, since traces of shortstop getting into the developer will reduce its alkalinity and make it weaker, and traces of fixer will cause fog and staining of the prints. The

use of print tongs is preferable to handling prints with the fingers, but it should be remembered that print tongs must be washed off just as often as your hands if they are to be used to transfer a print from developer to shortstop, or to the fixer. Two pair of tongs, one for developer and one for shortstop, will eliminate constant washing off.

If a large number of prints have to be made at one sitting, it is sometimes advantageous to expose several of them and then develop them at one time. In this case the number should be kept small enough so that they can all be inserted in the developer simultaneously, agitated frequently during development, and timed exactly, so as to get uniform density and contrast. A few seconds one way or the other in a print developer can make a considerable difference in the appearance of a print.

The Acid-Shortstop

The shortstop bath for prints should be made by adding one ounce of 28% acetic acid, or one ounce of Edwal Signal Shortstop to one quart of water. When a print is removed from the developer it is saturated with the developing solution, which is quite strongly alkaline. When this print is immersed in the shortstop bath, the acid quickly neutralizes the alkali of the developer solution that is carried over and stops development immediately. The use of a shortstop thus prolongs the life of the fixing bath, because it prevents the alkali carried over from the developer from getting into the fixing bath and neutralizing the acid which is necessary for proper hardening action.

It is common practice to make up an acid shortstop bath fresh for each batch of prints, and then throw it away without regard to whether it is exhausted or not. This is a good procedure except where very large quantities of prints are to run through, in which case the shortstop bath may become exhausted without any warning to the user. Edwal Signal Shortstop is designed to give a warning when it is approaching exhaustion because it contains an indicator which changes color just before all the acid in the shortstop bath is neutralized by alkali from the developer. The color of the indicator is yellow as long as the bath is acid, but becomes purple just before it reaches the alkaline stage. This is useful not only in a shortstop, but in a fixer as well where it is necessary to be sure that the acidity of the solution is being maintained. Signal Shortstop has the same acid strength as 28% Acetic Acid, and can be used in place of the latter in any of the standard shortstop or fixer formulas.

If Edwal-102 developer is used, it is best to use a shortstop made up by dissolving one ounce of Citric Acid in a gallon of water rather than the usual Acetic Acid or Signal Shortstop. Even here, however, a small

amount of Signal Shortstop (up to one ounce per gallon) can be added if the indicator feature is wanted.

Fixing

For best results the fixing bath should be freshly mixed up just before using. However, at normal temperatures (55 to 70°) the bath can be used over and over until the clearing time begins to rise, or until the bath begins to foam due to absorption of gelatin from the prints which have been processed.

Prints should be fixed ten minutes in an ordinary hypo type fixer, such as Edwal Acid Fix or Liquid Fix. When the fixer is fresh a somewhat shorter fixing time may be used, provided it is at least twice the length of time necessary to clear a test piece of film, as described in Chapter II. Prints need only be fixed one to two minutes in Edwal Quick-Fix at its high-speed strength (1:3 dilution of the concentrate) and should *not* be left in this fixer for longer than three minutes. The fixing action of Quick-Fix is so powerful that the oxygen dissolved in the fixing bath will convert the smaller grains of silver into a silver salt which can be dissolved by the fixer, thus causing gradual weakening of the image. Prints being fixed in Quick-Fix should be agitated frequently in the fixer, just as they are agitated in the developer. No matter what type of fixer is used, prints should not be allowed to remain in it unnecessarily long, since over-fixing causes the formation of a variety of silver salts which do not easily wash out of the emulsion. An over-fixed print, unless washed for a very long time, may retain enough silver salt to cause discoloration later on when the print is stored. This discoloration is of the same general type as that caused by under-fixing (not leaving the print in the fixing bath long enough to completely convert all the silver bromide to a soluble salt which can be washed out).

Prints fix more rapidly in a warm fixing solution than in a cold one, just as they develop more rapidly in a warm developer than a cold one. Fixing at high temperatures should always be done with a fresh fixing bath, since at temperatures above 80° F, there is some tendency toward toning of the image which results in off-color prints, especially if the fixer is old or has been overworked.

Washing

As described in Chapter II, most rapid washing is obtained if the wash water for prints is 75° F. or over. Prints fixed in Edwal Quick-Fix (high-speed dilution) should be washed 15 to 20 minutes. Those fixed in Edwal Acid Fix or Liquid Fix or other hypo-type fixer should be washed 20 to 30 minutes. If cold water is used for washing, the washing time should be prolonged as shown in the table (Page 22). The standard

practice has long been to wash prints for an hour, which usually results in reasonably complete removal of the fixing agent and dissolved silver salts unless the water is very cold indeed.

One way of testing to see whether washing is complete is to test for the presence of thiosulfate by the following method:

Make the following stock solution:

	Metric	*U. S. Units*
Distilled Water	**500 cc**	**16 ounces**
Potassium Permanganate	**½ gram**	**7½ grains**
Sodium Hydroxide	**1 gram**	**15 grains**

To make the hypo test mix 1 cc (¼ dram) with 120 cc (4 ounces) of distilled water and pour 15 cc (½ ounce) into a clean glass graduate. Take the print out of the wash water and after most of the water has run off, allow 4 or 5 drops to run into the graduate. If the color of the solution changes from purple to orange, even slightly, hypo is still present in the print and it should be washed more. Distilled water should be used in the solution for the hypo test because tap water often contains organic matter which would cause the color change whether hypo is present or not. There is also on the market a prepared solution called Hypo Sharp which tests for hypo by means of a different chemical reaction which does not involve permanganate.

If a print has been over-fixed, the fact that the above test no longer shows the presence of thiosulfate does not mean that all the silver salts are removed. In such a case a hypo eliminator may be used which converts the complex silver salts into a form which may be more readily washed out. Hypo eliminators do not, however, do any appreciable good on normally fixed prints. A formula for a hypo eliminator is as follows:

HYPO ELIMINATOR

	Metric	*U. S. Units*
Water	**500.0 cc**	**16 ozs.**
Hydrogen Peroxide (3% solution)	**125.0 cc**	**4 fl. ozs.**
Ammonia (3% solution)	**100.0 cc.**	**3¼ fl. ozs.**
Add water to make total volume of	**1.0 liter**	**32 ozs.**

Wash the prints for about 30 minutes at 65° to 70° (18° to 21° C) in running water which flows rapidly enough to replace the water in the vessel (tray or tank) completely once every 5 minutes. Then immerse each print for about 6 minutes at 70° F (21°C) in the Hypo Eliminator solution and finally wash about 10 minutes before drying. At lower temperatures increase the washing times. For double weight prints washing time should be doubled.

Drying

Glossy surfaced prints, when removed from the wash water and drained, may be dried on a ferrotype plate in order to give a very high sheen. The procedure is to clean the ferrotype plate and polish it with a few drops of Edwal Ferrotype Polish. The print is then pressed face down into close contact with the polished surface of the ferrotype plate, excess water is removed with a roller or squeegee, and the print is allowed to dry without being disturbed. The ferrotype plate may be warmed slightly during the drying process in order to speed it up, but excessive heat or strong drafts from an electric fan are not recommended, since they will cause uneven drying which produces marks on the surface of the print, and sometimes causes sticking.

Matte or rough surfaced papers are removed from the wash water and blotted or wiped free of surface moisture. They may then be dried between blotters under pressure, or may be spread out on cheese cloth racks or newspapers. In the latter cases they should be turned over occasionally during drying to minimize curling. Curling may be largely prevented if the prints are placed under pressure between blotters under a pile of heavy books or other objects before they are completely dry. If a print does curl excessively, this can be remedied by soaking it for a few minutes in a 5% solution of glycerin in water.

This practice is not particularly recommended for prints that are to be kept permanently because the glycerin will tend to keep the gelatin slightly moist which will result in a tendency to mildew or mold during storage.

Cleanliness

Keep things clean—hands, trays, film, lenses, work-tables. Washing the hands before development prevents finger-stained prints. Wiping off tables, shelves, etc., with a damp cloth removes dust which might get on film or negative-holders. Dry chemicals should never be mixed or handled in the darkroom because the dust gets in the air and settles on paper and other objects and soon there is a green or brown or purple stain where each particle settled.

If developer or hypo is spilled on the work-table or floor it should be mopped up with a wet cloth. If the spilled solution is allowed to dry and is walked on or rubbed with a tray, enough chemical dust is scattered into the air to ruin plenty of film or paper.

Wesley Bowman Studios

Print developed in Edwal-111.

Chapter V

EDWAL DEVELOPERS FOR PRINTS

A POSITIVE picture, or print, is made to be looked at, while a negative is not. Because of this there are some fundamental differences, as well as some similarities, between developing methods for prints and for negatives. Before getting down to practical details, therefore, we will outline some of the characteristics of a good print and tell how to regulate them.

Contrast

The contrast of a print, like that of a negative, is the difference between the darkest tone and the lightest one in the picture. If this difference is great the print is said to be "contrasty" or "snappy." If the difference is not very great the print is "soft" or "flat." Sometimes strong contrast is wanted and sometimes it is not, depending on the effect desired by the print maker.

Contrast in a negative is commonly increased by increasing the developing time or decreased by shortening the time. This method of control is very little used in print making. With chloride (contact printing) and bromide papers practically no variation of contrast can be obtained during development. Even with chlorobromide papers the degree of variation is limited.

Generally speaking the contrast is built into the paper emulsion by the manufacturer, and one picks a "hard" or a "soft" grade of paper according to the requirements of the picture. However, with any one grade of paper, stronger contrast can be obtained by using a concentrated developer, and less contrast by using a fairly dilute one. Most print developers are made up as stock solutions that are diluted with a specified amount of water before using. This is very convenient, for if strong contrast is needed, one merely dilutes the stock solution with less than the recommended amount of water. If softer prints are wanted one dilutes the stock with more water than usual.

Density

If the silver image in a print is very heavy, the print is not usually called "dense" as a negative would be, but is referred to as a dark or "low-key" print. Similarly, a print with a thin silver deposit is called a light or "high-key" picture.

Density in the print should be controlled almost entirely by exposure. If a print has been over-exposed, any attempt to keep the density down by shortening the developing time results in a muddy-looking picture with an off-color image. If a print is under-exposed, density can be allowed to build up to some extent by prolonged development, especially with the Edwal-102 or Edwal-106 developers. However, with too long a developing time, any developer (particularly those containing metol) will produce yellow stains and sometimes fog on the print.

The best way to control density is to determine the correct exposure by means of one of the exposure-meters made for the purpose, or by making "test strips" on which different parts of the same paper are given different exposures and then the correct exposure is determined by development of the strip.

Tone

The tone or color of the silver deposit in a print is very important. If the image is black with a slight bluish tinge, it is said to have a "cold" tone. If it has a brownish cast it is said to be warm-toned. Many papers tend to produce greenish or olive images, and these are also called warm tones, especially if there is some admixture of brown.

Each type of tone is good for some particular type of picture, though individual tastes differ quite widely on this point. Generally the neutral or "true-black" tones produced by Edwal-102 or Edwal-111 are most pleasing in the general run of pictures. Warm tones are often desired in portraits and landscape pictures and cold bluish-blacks are wanted in commercial photographs. Because of this the various Edwal paper developers are classified according to the tone they tend to produce. However, with any one developer, some papers will produce colder tones than others. It is also true that with any developer and any paper, a colder tone is produced by a long developing time and a warmer tone by a short developing time.

Print Quality

Aside from tone, density, and contrast, print quality is made up of a number of factors such as accuracy of gradation, sharpness of detail, type of paper surface, etc., over which the photographer has little control during development. The accuracy with which gradations and details are rendered depends partly on the paper used and partly on the constitution of the developer. Thus, the slow chlorobromide papers are better than the fast chlorobromides, and these in turn are better than the bromides for rendering delicate gradations and fine detail. Likewise, with any particular brand of paper, developers containing Monazol (Edwal-

102) or Amidol (Edwal-126) generally produce better gradations than those which do not.

Of course there are subjects where accurate recording of fine detail is not needed — in fact, not desired. Some subjects call for bold masses of tone, with detail only suggested or made unobtrusive. For such pictures, bromide papers and developers such as Edwal-120 are best. For the general run of pictures, Edwal-110 or Edwal-111 is recommended, especially with chlorobromide papers.

Classification of Papers

There are four general types of printing papers in common use. The bromides contain silver bromide as the light-sensitive agent and are used as fast enlarging papers. The fast chlorobromides require from two to four times as much exposure as the bromides, but are capable of recording fine detail more accurately. The slow chlorobromide papers require still longer exposure and are better than the fast chlorobromides for accurately rendering detail and delicate gradations. They can be used either for enlarging or for contact printing. As a group they tend to give warm tones. The fourth group, the chloride papers, are used exclusively for contact printing. With some brands, 4 or 5 grades of contrast are available.

Examples of the four classes are: *Bromide* (fast enlarging): Brovira, Charcoal Black, Coloma Kruxo, Gevaluxe Velours, Haloid Press Bromide, Haloid Record, Haynes Salon Special, Kodabromide, Marful Duplex, Novabrom, Portrait Proofing, Projection Proof, Record Kruxo, Stripping Kruxo, Translite Enlarging, Translux Kruxo, Transparex.

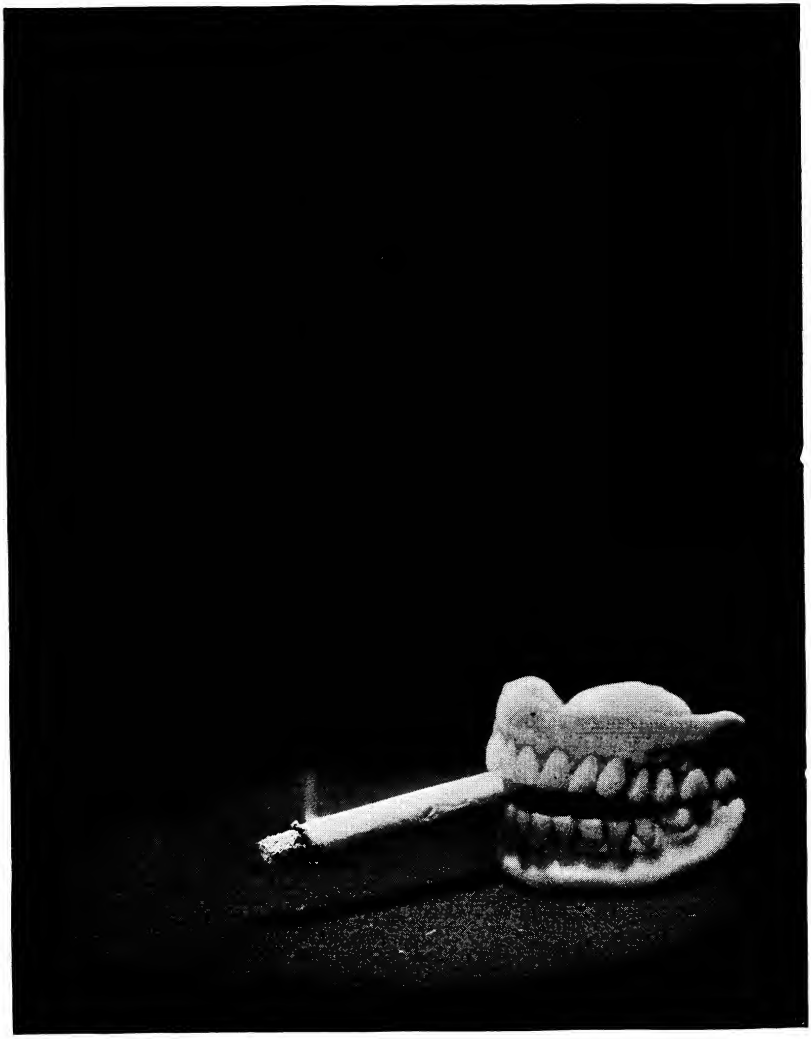
***Fast Chlorobromide* (enlarging): Agfa Portrait Enlarging Artex Projection, Artona Rapid, Cykora, Halobrome, Illustro, Novatone Rapid, Projecto, Varigam, Velour Black, Vitava Projection.**

***Slow Chlorobromide and Fast Chloride* (enlarging and contact): Copy House Enlarging Kruxo, Cykon, Illustrator's Special, Indiatone, Kodalure, Larjex, Marvel Brome, Portrait Enlarging Kruxo, Proof Kruxo, Veltura, Vitava Athena, Vitava Opal.**

***Chloride* (contact): Acme Kruxo, Ad-Type, Agfa Professional Papers (Cyko, Crystal Stipple, etc.) Apex, Artona Contact, Artura Iris, Azo, Commercial Kruxo, Convira, Halo, Industro, Letter Copy Kruxo, Marvel Contact, Novaflex, Novagas, Portrait Kruxo, Speedex, Velox, Wards Contact.**

Which Print Developer is Best?

There is no answer to the question, "which is best" unless one specifies "best for what?" Most people prefer a true neutral black image with neither a cold bluish nor a warm brownish tone. Hence for most amateur work, the Edwal-111 formula is recommended. If, however, the picture has many delicate gradations of tone (e.g. a blonde woman's portrait)



"Doctor's Out" *E. D. Nunn*

From a negative developed in Edwal-12.

Edwal-102 will be better. On the other hand, for subjects such as are encountered in stage photography where unnecessary detail is to be suppressed in the darkest portions of the print, Edwal-120 would be better.

For commercial work or for subjects which require a cold black tone, Edwal-126 or Edwal-110 would be suitable, the choice depending on whether very delicate gradations were needed or not. Or if brownish tones were preferred in an outdoor picture or portrait, Edwal-106 or 108 would be suitable. As some wise man said, "Tastes differ." Further recommendations are made in Chapter VII.

FORMULAS FOR TRUE-BLACK TONES

EDWAL-102—For delicate gradations.

	Metric	*U. S. Units*
Water	**900 cc**	**30 ounces**
Sulphite (Edwal)	**80 grams**	**2-2/3 ounces**
Edwal T. S. P.	**120 grams**	**4 ounces**
Monazol	**25 grams**	**375 grains**
Potassium Bromide	**3 grams**	**45 grains**
Water to make	**1 liter**	**1 quart**

(Available in prepared form)

To Use: Dilute with 3 parts of water for chloride and chlorobromide papers; with 4 parts of water for bromide papers.

Note: A variation of the above formula may be made by which an equal amount of Potassium Carbonate is substituted for the T. S. P. and 10 grams per liter (150 grains per quart) of Sodium Hydroxide (Caustic Soda) is added to make up for the lower alkalinity of the carbonate. This variation permits the use of a regular acetic acid stopbath instead of citric acid.

Edwal-102 is slower working than most print developers. The image usually appears in 1 to 1½ minutes and development is complete in 3 to 4 minutes. There is considerable latitude as to developing time, for pleasing tones can be obtained with any development from 2 to 6 minutes, thus allowing greater latitude in exposure time than with most formulas. The longer the developing time, the colder will be the tone.

Edwal-102 works best at 60 to 70° F. but can be used up to 90° F. if necessary. At higher temperatures the maximum developing time (without staining) is decreased from 6 minutes at 65° to 4 minutes at 85°. If possible, Edwal Thermo-Salt should be added to the developer when the temperature is 80° or above.

Prints developed in Edwal-102 should be rinsed for at least 2 minutes in a short-stop bath containing 1 ounce of citric acid per gallon of water to remove as much of the T. S. P. as possible before going into the fixing

bath. Edwal Acid Fix should always be used with Edwal-102 or any other developer containing trisodium phosphate, because this Acid Fix has been so compounded as to prevent precipitation of insoluble aluminum phosphate in the fixer.

If aluminum phosphate is precipitated it may stick to the emulsion and spoil the luster of the finished print by leaving "hen-tracks" when it dries. If this should happen due to incorrect procedure, the precipitate may be removed by soaking the print in water, then briefly swabbing it with 5% hydrochloric acid and washing it for two or three minutes in running water.

Edwal-102 keeps well in the stock solution but will oxidize quite readily after it has been diluted. The diluted developer sometimes acquires a very dark color during use but this does not indicate exhaustion, as it will keep on developing prints long after it has acquired the color of motor-oil. The stock solution is very concentrated and will crystallize if stored at low temperatures. This may be remedied, if necessary, by diluting with an equal volume of water.

Edwal-102 for Lantern Slides and Negatives

Edwal-102 at the 1:3 dilution is an excellent developer for lantern slides. Its fog-producing tendency is so low that the necessity for treatment of the slides with ferricyanide to remove fog is eliminated and as a result much fine gradation and detail are saved.

Edwal-102 can be used to develop negatives if fine grain is not needed. For normal negatives, dilute with 3 parts of water and develop 4 to 6 minutes for common roll films. Higher dilutions may be employed for tank development. When diluted with 9 parts of water, develop 7 to 11 minutes, at 1:14 develop 10 to 14 minutes, and at 1:24 develop 15 to 19 minutes depending on the contrast desired.

EDWAL-111—For general print making.

	Metric	*U. S. Units*
Water	**900 cc**	**30 ounces**
Metol	**5 grams**	**75 grains**
Sulphite (Edwal)	**80 grams**	**2-2/3 ounces**
Monazol	**6 grams**	**90 grains**
C. H. Q.	**15 grams**	**225 grains**
Potassium Carbonate (Edwal)	**120 grams**	**4 ounces**
Potassium Bromide	**3 grams**	**45 grains**
Water to make	**1 liter**	**1 quart**

(Available in prepared form—both liquid and powder)

To Use: Dilute with seven parts of water for bromide papers, and five parts for fast chlorobromides (e.g. Vitava Projection). For slow chlorobromides (e.g. Opal, Indiatone, etc.) and contact papers, dilute with four parts of water.

Edwal-111 produces true black tones, with excellent contrast and detail. We believe it to be the best formula that has ever been devised for general amateur use.

The developing time for enlarging papers is 1½ to 3 minutes. The best black tones are obtained with a developing time of 2 minutes or over.

For tray development of negatives dilute with 8 parts of water and develop roll films 5 to 7 minutes. For tank development dilute with twenty parts of water and develop 15 to 18 minutes at 65° F.

EDWAL-120—For rich dense blacks.

	Metric	*U. S. Units*
A. Catechol (Edwal)	**20 grams**	**300 grains**
Sulphite (Edwal)	**40 grams**	**1-1/3 ounces**
Water	**1 liter**	**1 quart**
B. Potassium Carbonate (Edwal)	**120 grams**	**4 ounces**
Water	**1 liter**	**1 quart**

For chloride and slow chlorobromide papers, mix one part A and two parts B and add ½ ounce 1% Orthazite stock solution per quart of developer. For fast chlorobromide, mix one part A, two parts B, and one part of water and add ½ ounce 1% Orthazite per quart. For bromide papers, mix one part A, two parts B, and two parts of water. Add 1 ounce 1% Orthazite per quart of dilute developer.

Edwal-120 produces very rich black tones and is useful for prints where bold masses of tone are desired (i.e. stage shots, etc.) and detail is to be suggested rather than rendered with great exactness. The developer can be made to give finer detail if desired by increasing the amount of Orthazite or by adding a little potassium bromide.

For tray development of negatives, mix one part of A, two parts of B, and one part of water. Develop 5 to 7 minutes.

FORMULAS FOR COLD BLUE-BLACK TONES

EDWAL-126—For delicate gradations.

	Metric	*U. S. Units*
Water	**900 cc**	**30 ounces**
Edwal Sulphite	**25 grams**	**375 grains**
Amidol (Edwal)	**6 grams**	**90 grains**
Potassium Bromide	**0.8 grams**	**12 grains**
Water to make	**1 liter**	**32 ounces**

This developer should be made up just before use, but can be kept for a few days in full tightly closed bottles, if necessary.

For development of chloride (contact) papers use Edwal-126 full strength and develop about 1 minute. For chlorobromides dilute with an equal volume of water and for bromide papers with 2 parts of water. Develop 1½ to 3 minutes. For softer pictures dilute with more water and for stronger contrast dilute with less water.

For tray development of negatives use Edwal-126 full strength and develop 3 to 7 minutes at 65° F. depending on the type of film used and the contrast desired. One pint will develop 2 dozen 3¼ x 4¼ negatives or an equivalent area of other film safely.

EDWAL-110—For general print making.

Stock Solution	*Metric*	*U. S. Units*
Water	**900 cc**	**30 ounces**
Metol	**2.5 grams**	**37 grains**
C. H. Q. (Edwal)	**7.5 grams**	**112 grains**
Sulphite (Edwal)	**30 grams**	**1 ounce**
Potassium Carbonate (Edwal)	**60 grams**	**2 ounces**
Orthazite	**2 grams**	**28 grains**
Water to make	**1 liter**	**1 quart**

To Use: Dilute with four parts of water for bromide papers, three parts of water for chlorobromides, and two parts of water for chlorides for cold bluish blacks, especially on papers. For stronger contrast, increase the amount of C. H. Q. up to 10 grams (150 grains). For less contrast, cut the C. H. Q. to 5 or 6 grams (75 to 90 grains).

FORMULAS FOR WARM TONES

EDWAL-106—The auto-toning developer.

	Metric	*U. S. Units*
Water	**900 cc**	**30 ozs.**
Sulphite (Edwal)	**85 grams**	**2¾ ozs.**
Sodium Carbonate (Anhyd.)	**145 grams**	**4½ ozs., 42 grains**
Monazol	**28 grams**	**¾ oz., 73 grains**
Hydroquinone	**9 grams**	**¼ oz., 24 grains**
Potassium Bromide	**4 grams**	**57 grains**
Water to make	**1 liter**	**32 ozs.**

With contact papers, Edwal-106 produces tones that vary from greenish brown to sepia and brick-red. With the slow chlorobromide papers it produces delicate tones that are very beautiful in high-key work, and with the fast chlorobromides it produces warm blacks and brown-blacks.

For bromide papers dilute with 3 parts of water for warm black tones. With Brovira, diluting Edwal-106 stock solution with 7 parts of water will produce brown tones. For chloride and chlorobromide papers, dilute with 7 parts of water and develop 4 to 6 minutes for brown-blacks. For brighter tones on chloride papers use 3 to 8 times the normal exposure and develop only until full detail is obtained (70 to 90 seconds). At a dilution of 15:1 Edwal-106 produces the so-called "gravure-brown" tones on enlarging papers and delicate green tones on Opal.

The tones obtainable with Edwal-106 on the chloride papers are worthy of detailed description. At 3 times normal exposure the following tones are obtained:

Artura Iris	Green
Apex	Red to red-brown
Azo	Brown to red-brown
Convira	Brown to red-brown
Cyko	Brown
Larjex	Red to brown
Novagas	Chocolate brown
Velox	Red-brown to brick-red
Vitava Athena	Sepia

As exposures are increased to 8 times normal the tones become brighter and tend toward brick-red. Increase beyond 8 normal does not produce any marked change. Developing times at 3 times normal exposure are 60 to 90 seconds and at 6 times normal exposure, 50 to 70 seconds. It is generally true that the tones appear somewhat brighter while the print is wet than after it has dried.

In determining the tone desired on contact paper a series of exposures 1, 2, 3, 4, 5, and 6 times normal, etc., should be made on separate strips and developed to the proper density. These should be fixed, washed and dried before finally judging the tone. Enlarging papers should not be given more than 1 to 1½ times normal exposure. Any contact paper will give pleasing tones with normal to 2 or 3 times normal exposure, but Artura Iris, Velox and Vitava Athena are especially good because of the richness and beauty of the tones which they give with the longer exposures from 3 to 6 times normal.

When a large number of prints are to be made from one negative, the exact exposure and developing time necessary to produce the desired

tone should be determined and then each print should be exposed and developed according to these times. Otherwise, it is sometimes hard to match tones exactly if development by inspection is relied on.

A developer which is excellent for prints which are to be toned blue by a gold-chloride toner is

EDWAL-113

	Metric	*U. S. Units*
Water	**500 cc**	**16 oz.**
Sulphite (anhydrous)	**8.5 grams**	**128 grains**
Chlorhydroquinone	**1.1 grams**	**17 grains**
Sodium Carbonate (anhydrous)	**8.5 grams**	**128 grains**

Use without dilution. Development is carried on for about 1½ minutes and the print has a brownish tone on the slow chlorobromide papers for which it is recommended.

Color Separation Negatives and Positives

Because of the relatively long exposures that are required by the "one-shot" color cameras a developer must be used which does not sacrifice emulsion speed and at the same time produces fine grain. Edwal-12 is recommended and widely employed for this purpose. However, some workers prefer a softer working developer and have found that Edwal-12 with the Monazol reduced to 2 grams per liter serves their purpose very well.

For development of color separation positive (dye-tone process) the following Catechol formula has been found satisfactory:

EDWAL-121—For color positives.

	Metric	*U. S. Units*
Water	**400 cc**	**13 ounces**
Sulphite (Edwal)	**25 grams**	**375 grains**
Catechol (Edwal)	**10 grams**	**150 grains**
Sodium Carbonate (anhyd)	**50 grams**	**1-2/3 ounces**
Potassium Bromide	**2 grams**	**30 grains**
Water to make	**500 cc**	**1 pint**

Dilute the stock solution with 5 parts of water and develop 7 to 10 minutes. A 1:8 dilution may also be used and development carried on for 13 to 17 minutes.

Chapter VI

TECHNIQUE

A chapter on "How to do it"

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EVERY photographer who mixes his own solutions from the pure chemicals, or who wants to do things out of the ordinary, encounters questions of procedure which he cannot answer unless he happens to be a chemist. It is the purpose of this chapter, therefore, to present a few of the "do's and don'ts" concerning ordinary chemical manipulations such as mixing and storing solutions, etc. The material included here is the result of several years of answering similar questions from amateurs all over the country.

Mixing and Storing Developers

It is usually specified that when the chemicals in a developer or fixer are being dissolved, they should be added in the order given in the formula. Each chemical should be completely dissolved before the next one is added. With most developers this is primarily a matter of convenience. Thus, Metol is usually dissolved before sulphite because Metol dissolves rapidly in plain water but only very slowly if the sulphite is dissolved first. In Monazol formulas the sulphite and the alkali (if any) are dissolved first because Monazol will not dissolve at all unless sulphite or an alkali is present.

Most developers are mixed in warm water (125° F.) and the sulphite is added as early as possible. This is because the sulphite removes the dissolved oxygen from the water, especially when the solution is warm, thus preventing oxidation of developing agents which are added later. If developers are to be stored for long periods their keeping qualities can be improved somewhat by adding part of the sulphite to the water and boiling for about 10 minutes before adding the remaining chemicals.

Developers should always be mixed in glass, enamelled, bakelite, or stainless steel vessels. Pewter, brass, or copper vessels, whether plated or not, should never be used. They contaminate the developer causing fog and, in the case of fine grain developers, coarse grain and excessive contrast. Developers should never be mixed in aluminum, because the alkalies attack the metal.

A developer will gradually oxidize if stored in a partly filled bottle, thus losing its strength. It has been suggested that bottles of developer

should be kept full by dropping glass beads or marbles into the solution. This is not recommended with fine grain developers because beads and marbles are made of cheap glass or porcelain that may give off alkali to the solution.

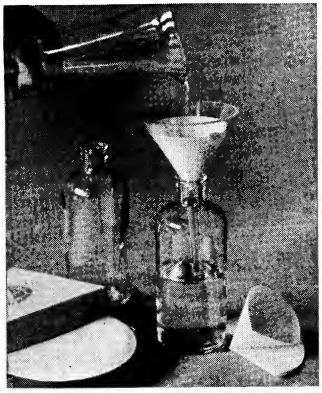


Fig. 8 — Filtering a solution through a folded filter paper in a glass funnel. The filter paper lying on the table near the bottle illustrates the method of folding before putting the paper into the funnel.

It is best to use bottles of different shapes for different types of solutions so they can be easily distinguished in the dim light of the darkroom. Labels should be large and lettered in large characters, and should be covered with melted paraffin (applied with a small brush) or nitrocellulose lacquer to prevent dripping solutions from blurring the letters. If stock solutions are to be stored it is best to use a series of small bottles which hold, either the exact amount to be used, or enough for 2 or 3 withdrawals at the most.

When bottles of the exact size desired are not available, larger bottles may be adjusted to the desired size by filling the extra space with canning paraffin. This may be done by making the paraffin wax into marbles and dropping them into the bottle of solution, but more conveniently, the melted paraffin may be poured into the empty, dry bottle and allowed to harden before the developer is poured into the bottle. To determine the amount of paraffin needed, put into the bottle the amount of developer desired, cap it and turn the bottle upside down. Mark the liquid level thus obtained and after emptying and drying the bottle, the paraffin may be poured in up to this level so that you will have exactly the right space for the developer you wish to store.

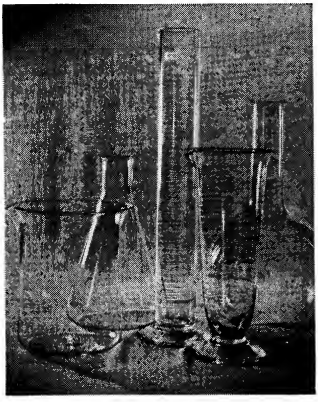


Fig. 9—Pyrex flasks, beakers, and graduates which are useful in handling photographic solutions.

The best type of closure for a developer storage bottle is a rubber stopper, though a good cork is satisfactory if

paraffined to exclude air. Bakelite screwcaps are good and metal caps are satisfactory if lined with a resin or wax-impregnated disc to prevent contact of the solution with the metal.

Strongly alkaline developers, e.g. those containing carbonates or T. S. P., can be stored in practically any type of bottle. Fine grain developers such as Edwal-12 or Edwal-20 should never be stored in bottles which have previously held alkaline solutions, because such bottles gradually give off alkali to the solution causing the developer to become more and more active and give coarser and coarser grain. Most clear glass bottles give off alkali, even when new, and should not be used for fine grain developers. Pyrex flasks are safe for use, as are also the amber glass bottles made by the Owens-Illinois Glass Co.

Developers, in fact all photographic solutions, should be filtered or allowed to stand a day or two to clarify before use. If the latter method is used the clear solution should be poured off the insoluble matter into a clean container. Solutions are best filtered through regular folded filter paper in a glass funnel.

Measurement of Time, Temperature and Weight

Developing times and exposure times should, of course, be measured by a clock, watch, interval-timer, or stop-watch. The common practice of guessing or counting when timing exposures under an enlarger causes many incorrect exposures so that prints must often be "jerked" from the developer too soon, causing poor tones; or development must be "forced" causing stains.

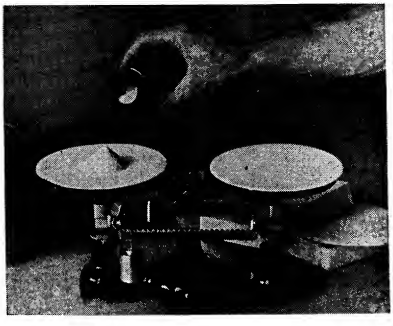
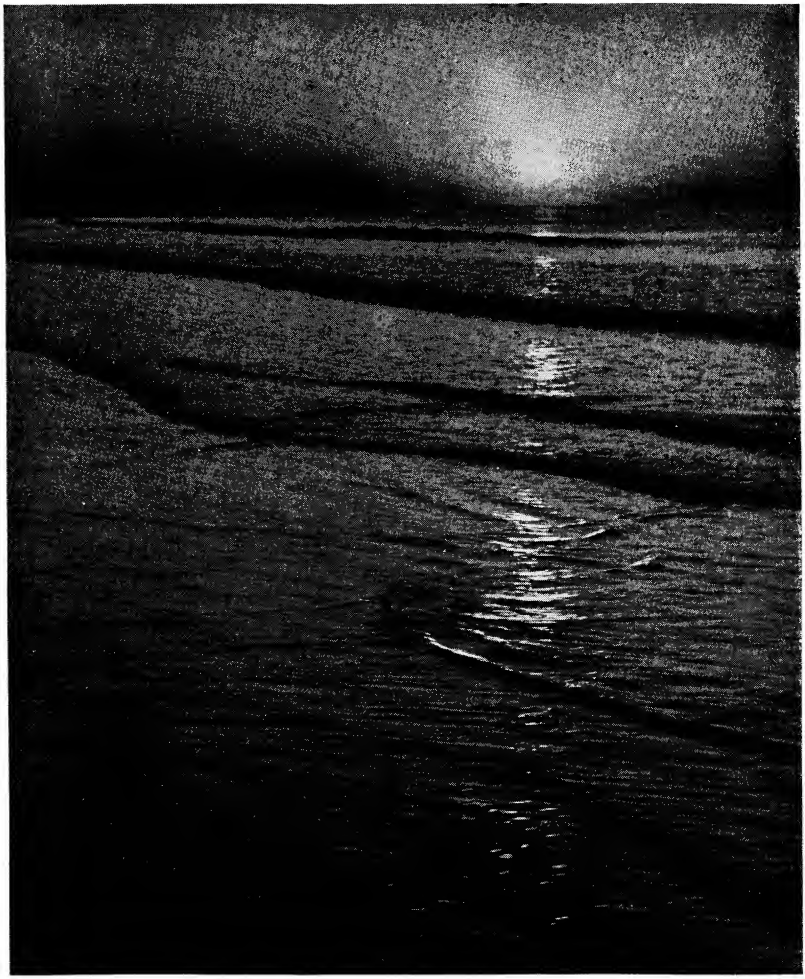


Fig. 10—A "trip-scale", showing the correct method of weighing chemicals with a clean piece of paper on the scale pan.

Film development must be timed with a watch or clock, and a standard procedure should be adopted for determining when to start timing development and when to stop. With small amateur roll-film tanks developing time should be counted from the moment you *begin* pouring developer in, to the moment you *begin* pouring it out. If the solution is poured into the tank about as fast as it is poured out this method of timing produces very uniform results. It goes without saying that the stop bath should be poured in as soon as possible after the developer is poured out.



"Another Day" *Hans Kaden*

From an Edwal-20 negative.

"In pictorial work, I consider the negative the first all important step. I prefer a delicate negative with fine graded half-tones and shadow details. That's why I use Edwal-20."—Hans Kaden.

Temperature of solutions should preferably be measured with a glass thermometer with the scale etched directly on the stem. Thermometers having metal parts other than stainless steel are apt to contaminate the solution. Thermometers with scales that can be moved or jarred out of position should not be used under any circumstances, because a difference of a few degrees in the temperature of a fine grain developer can make a large difference in graininess and contrast of the resulting negative.

For weighing photo chemicals, balances with an accuracy of greater than 1/10 of a gram (1½ grains) are very seldom necessary. Almost any balance or scale is good enough when it is new. However, with some of the cheaper balances, the accuracy decreases rapidly as the instrument gets older. Corrosion occurs on the metal balance points or "knife edges" and as a result many weighing instruments used by amateurs are not accurate within half a gram after a few years' use.

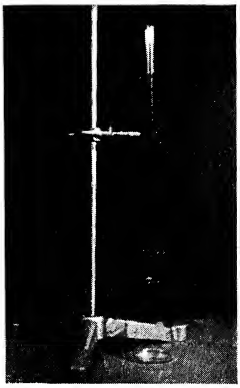


Fig. 11 — A burette, such as this, can be used in measuring small quantities of solutions accurately merely by opening the stopcock. A test tube is hung over the top to prevent evaporation.

For reasonable accuracy over a period of years, a balance such as the one illustrated in Fig. 10 (commonly called a "trip-scale") is recommended. It should have non-corrodible agate "knife-edges" or suspension points and the weighing pans should be easily cleaned so that they will not corrode or change weight readily. Such balances can be obtained at most camera supply stores or from one of the laboratory supply houses which sell scientific equipment.

On any balance, chemicals should never be weighed directly on the balance pan, but should be poured on a clean piece of paper placed on the pan. This avoids corrosion of the balance pan and contamination of the chemicals. A clean piece of paper should be used for each chemical so that if it is necessary to return some of the chemical to the bottle, it will not be contaminated with small amounts of other chemicals that have previously been weighed.

Measurement of Liquids

Liquids are best measured in transparent graduates such as those shown in Fig. 9. The bottom of the curved liquid surface or "meniscus" should be used in reading the volume. Non-transparent graduates, pitchers,

or buckets, with graduations marked on the inside do not usually permit of very exact measurements of volume.

For measurement of very small quantities of solution such as is necessary with stock solutions of potassium bromide or thiocyanate a small graduated cylinder or a burette (Fig. 11) are very convenient. The burette, especially allows repeated withdrawal of small quantities (½ to 5 cc) accurately and with great convenience. The upper end should be covered with a test tube to prevent evaporation, as shown in the illustration.

Tray and Tank Cleaning

Trays may be cleaned by rinsing with the following solution:

	Metric	*U. S. Units*
Water	**1 liter**	**32 ounces**
Potassium Dichromate	**90 grams**	**3 ounces**
Sulphuric Acid (concentrated)	**90 cc**	**3 ounces**

Pour a little of the tray cleaner into the tray to be cleaned and rinse it around so that it has access to all parts. Then pour the cleaning solution back into the stock bottle and rinse the tray thoroughly with plenty of water till all traces of cleaning fluid are gone. This solution will remove stains caused by oxidized developer, silver stains, and some dyes. It is strongly acid and should be kept in a glass-stoppered bottle. It should be used only on glass, porcelain, or enamelled ware — never on metals, wood or rubber.

Bakelite, rubber, or metal trays or tanks should be cleaned by rubbing with White Rit or a mixture of Dreft and sodium bisulphite.

Stain Removal

Stains on cloth, wood, linoleum, etc., can be removed with such products as White Rit, Tintex Color Remover, Dytint Color Remover, etc. Cotton cloth can be boiled with this product in water if necessary. On wool cloth, wood, or linoleum, the White Rit is rubbed on with a damp rag, allowed to soak in for a short time, acidified by pouring on a little vinegar or 10% acetic acid, and then washed well with plenty of water. Generally the use of a rubber apron of the type shown in the illustration will prevent stains on clothing.

Dry Amidol, Pyro, or Diamine-P powders will stain the hands if allowed to remain for any length of time, not because they are colored substances, but because they gradually oxidize to form dyes which are hard to remove from the skin. Pyro and Diamine-P solutions also cause

stains. Such stains may be prevented through washing with plenty of soap and warm water within 15 minutes of the time the hand first touches the developer. After the stain has formed it is hard to get off, but can be removed by the following rather vigorous treatment:

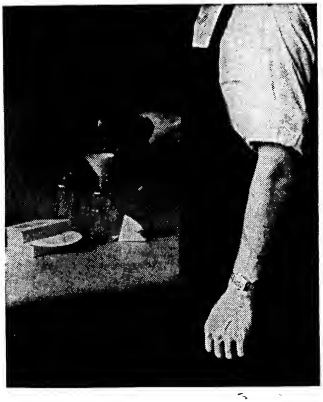


Fig. 12—A rubber apron such as this one prevents stained clothing when mixing solutions.

After wetting the hands take some crystals of potassium permanganate and rub around on the wet, stained area for a few minutes. This produces a deep brown stain. Then rinse off with a 5% hydrochloric acid (1 part concentrated 36% acid to about 6 parts of water). If the developer stain is very old or very deep, 3 or 4 repetitions of this treatment will be necessary, applying alternately the permanganate and hydrochloric acid. *Rinse hands finally with water.* (In the above treatment sodium bisulphite or oxalic acid cannot be substituted for hydrochloric acid, though these substances are sometimes recommended. The hydrochloric acid must be used, especially with diamine stains.)

At the end of the treatment, some brown permanganate stain may be left. If so, this can be removed by rinsing once with sodium hypochlorite solution, which is sold at grocery stores as Chlorox, Linco, etc.

An easy method of preventing stained hands is to wear rubber gloves. These should be washed with a little Ivory soap and warm water and rinsed well before using the first time, to prevent possible contamination of the developer solution.

Film Cleaning

When film is handled it is apt to acquire finger prints, dust particles, and other types of foreign matter which will cause print defects when enlargements are made from the negatives. Such foreign matter is sometimes removed by wiping the film with a lintless cloth moistened with alcohol, carbon tetrachloride, or other liquids which will dissolve grease.

Generally, carbon tetrachloride or cleaning preparations based on it should be avoided because the necessary rubbing generates static electricity which makes dust adhere to the film in dry weather. The formula on which Edwal Film Cleaner is based was designed not only to remove dirt and grease but to prevent static charges. Hence this preparation should be used if possible for cleaning film, plates, slides, etc.

A cloth which has been incorrectly laundered often contains small amounts of soap or laundry-bleach and should not be used in cleaning film. The film cleaner will dissolve soap or laundry-bleach from the cloth and leave streaks on the film. The following method of washing will insure the absence of impurities in the cloth:

Take a lint-free cloth and wash it thoroughly in warm water and Ivory soap or Dreft. Rinse the cloth thoroughly in at least 3 fresh batches of warm water and finally in running water. Dry in a dust free room. Cut the cloth into small squares about 3 or 4 inches across and store in a card board box or other clean container. Each square should be used for cleaning a single batch of film and then put aside for rewashing. If this procedure is followed, the film will be thoroughly cleaned and the cleaning fluid will never be contaminated with soap or other soluble matter. The cleaning fluid can be used down to the last drop and a 4-ounce bottle will last for years.

Intensification of Fine Grain Negatives

Numerous methods of intensifying negatives have been published and can be found in almost any photographic text or handbook. However, all the methods we have tried, except that using chromium, increase grain size very greatly. The chromium intensifying method is given here as the one best suited for use with small negatives.

In intensification with chromium the negative is bleached in a solution of potassium dichromate and hydrochloric acid, and the negative re-developed in amidol (Edwal-126). Alkaline re-developers should not be used because the grain is greatly increased. Fine grain developers should not be used for re-developing the bleached negative because their high silver-solvent action tends to weaken the image. As long as amidol is used as the re-developer, the process can be repeated over and over if sufficient intensification is not obtained the first time. It should be remembered, however, that each repetition increases grain size somewhat.

Film which has been processed in alkaline developers should be hardened in the hardener given below before intensifying. With negatives developed in non-alkaline developers (any Formula in Chapter III except Edwal-10), this hardening is usually not necessary or desirable.

FORMALIN-CARBONATE HARDENER

	Metric	*U. S. Units*
Formalin (37% formaldehyde)	**10 cc**	**2½ drams**
Sodium Carbonate (anhydrous)	**5 grams**	**75 grains**
Water to make	**1 liter**	**32 ounces**

After hardening for 3 minutes the film is rinsed briefly in water, fixed 5 minutes in a fresh acid fixing bath, and washed well before bleaching.

This same hardening process should also be used on negatives that are to be reduced or otherwise chemically treated.

CHROMIUM INTENSIFIER

	Metric	*U. S Units*
A. Potassium Dichromate	50 grams	1 ounce
Water to make	1 liter	20 ounces
B. Hydrochloric Acid, C.P.	100 cc	2 fluid ounces
Water to make	1000 cc	20 ounces

These solutions should be kept in glass-stoppered bottles, since both of them attack cork or metal and, to some extent, rubber. Different degrees of intensification can be obtained by using the two stock solutions in different proportions. To use take:

	I *Maximum Intensification*	*II* *Medium Intensification*	*III* *Minimum Intensification*
Solution A	4 ounces	8 ounces	8 ounces
Solution B	½ ounce	2 ounces	8 ounces
Water	16 ounces	10 ounces	4 ounces

The negative is bleached in solution I, II, or III until the color of the silver image has completely changed to a yellowish-brown. In the case of "super-fine" grain negatives which are already yellowish in color, the end-point is hard to detect but 3 minutes is a safe minimum with solution III, 4 minutes with solution II, and 6 minutes with solution I. The negative is then washed in running water until the yellow dichromate stain is removed (about 5 minutes) and then re-developed in a small dish of Edwal-126 until no further change is observed. After re-development the negative is washed about 10 to 15 minutes. If re-development is complete, no fixing is necessary. If, however, re-development is stopped before it is complete (in order to prevent too great intensification) the negative should be fixed for 5 to 10 minutes before washing.

The difference in degree of intensification between negatives bleached in solution I, II, and III is noticeable but not great. If very great intensification is needed, it is best to use solution II or III, re-develop, wash, and repeat the entire process one or more times.

Intensification by Toning

Photographic toners which are used to color prints by the addition

of a dye to the silver image may also be used to intensify the negatives. Blue or green dye toners are the best since they increase the density of the image to the photographic portion of the enlarging or printing light. The dilutions recommended for print toning may be used for this purpose but Edwal Thermo-Salt should be added to the bath to prevent reticulation. After toning the films should be washed to remove excess dye from the shadow areas of the negative where there is little silver. With very thin negatives the dye may be left even in the shadow areas to increase the over-all printing time for the negative to allow more control. If desired, the toning method of intensification may be used after the chromium intensifier to increase the total intensification.

Reduction of Dense Negatives

If a negative is too dense to give a good enlargement with a reasonable printing time it can usually be improved by treatment with one of the common reducing solutions. The type of reducer which should be used depends on the kind of negative that is to be reduced. If the negative is too dense because of over-exposure it is usually rather flat and a so-called "subtractive" reducer such as the ferricyanide-hypo bath, commonly called Farmer's Reducer, is best because it attacks the weaker parts of the image more than the denser portions, thus increasing contrast.

For negatives which have been badly over-developed and hence are very contrasty, a "super-proportional" reducer, generally containing ammonium persulphate is used because it tends to reduce contrast or "flatten" the image. Reduction does not usually cause an appreciable increase in graininess. On the other hand, while it may make individual grains smaller, it will not undo clumping that has taken place during development, and will not therefore make a fine or even-grained negative out of a "coarse-grained" negative.

The reducers given here do not comprise all the known formulas but are considered to be best suited to amateur or occasional professional use because they are easy to prepare and are not violently poisonous. Before reducing, negatives which have been developed in an alkaline developer should be hardened in the formaldehyde-carbonate bath described in the section on intensification. One negative should be handled at a time and it should be agitated frequently during treatment. All negatives should be thoroughly fixed and, except with the ferricyanide-hypo solutions, must be washed completely free of hypo before being placed in the reducer.

Following reduction, the negative should be washed thoroughly before drying.

FARMER'S REDUCER (subtractive type)

Solution A	*Metric*	*U. S. Units*
Water	30 cc	1 ounce
Potassium Ferricyanide	1 gram	15 grains
Solution B		
Water	1 liter	32 ounces
Hypo	30 grams	1 ounce

To use, add solution A to solution B and immediately pour over the negative to be reduced. The reducer deteriorates rapidly after the two solutions are mixed. The negative should be watched during reduction and when it has reached the desired density it should be immediately placed in running water and washed thoroughly before drying. The formula as given is fairly slow working, and allows a reasonable degree of control. If faster action is desired the amounts of ferricyanide and hypo may be proportionately increased.

The two solutions may be made up in more concentrated form if desired and used as stock solutions. However, the ferricyanide should be stored in a dark place since it is gradually decomposed by light. Farmer's Reducer applied with a cotton swab is useful in locally lightening small areas in prints. Also, negatives or prints which are slightly fogged may be improved by a brief immersion in Farmer's Reducer which has been diluted with 2 or 3 parts of water.

TWO SOLUTION FARMER'S REDUCER

This formula gives almost proportional reduction and can be used where it is desired to decrease general density without either increasing or decreasing contrast.

Solution A	*Metric*	*U. S. Units*
Water	1 liter	1 quart
Potassium Ferricyanide	7.5 grams	¼ ounce
Solution B		
Water	1 liter	1 quart
Hypo	210 grams	7 ounces

Harden the film (if developed in an alkaline developer) in the formalin-carbonate bath as described in the section on intensification. Immerse the negatives in solution A for 1 to 4 minutes with agitation. Then immerse in B for 5 minutes and wash thoroughly in running water. If

further reduction is necessary the process may be repeated, but unless the hypo is completely washed out of the film before returning it to solution A, the life of the ferricyanide bath will be considerably shortened.

PERSULPHATE REDUCER (Super proportional)

Stock Solution	*Metric*	*U. S. Units*
Water	1 liter	32 ounces
Ammonia Persulphate	60 grams	2 ounces
Sulphuric Acid (C.P.)	3 cc	¾ dram

After hardening the negative and washing thoroughly, as already described, immerse it in a solution of 1 part of stock reducer and 2 parts of water. When reduction has progressed far enough, immerse in an acid fixing bath (Formula Edwal-204, Chapter I) for a few minutes, wash thoroughly and dry. Dilution of the stock solution with less water will result in more rapid reduction, and dilution with more water will cause slower action.

Emergency Developing Techniques

Fairly good prints may be made from out-dated or slightly fogged photographic paper if extra restrainer is added to the print developer. A few drops of a 10% Potassium Bromide may be used, but if very much more is needed to counteract stain or fog on the paper, the image color will not be normal, and Edwal Orthazite will give a better result. Add from 1 to 3 fluid ounces of a 1% Orthazite solution. Such an addition to the developer will also make "green" unripe paper usable which otherwise gives greenish or brownish-black images.

When acetic acid is not available, distilled white vinegar may be used in its place. Such vinegar is approximately 4% Acetic Acid so that 7 times as much is required to replace 28% Acetic Acid.

If films or prints have been accidentally over-fixed, the necessarily long washing times may be shortened somewhat by bathing the films or prints in a .3% solution of Ammonia (10 cc of 28% ammonia per liter) after the first 10 minutes of washing. Three minutes in this solution followed by 3 minutes of washing will remove most of the fixing chemicals. A more effective hypo eliminator is made by using a .04% solution of Hydrogen Peroxide containing .04% of Ammonia. This solution requires a six minute treatment followed by a ten minute wash.

If the dye-backing color on roll or sheet films is not removed in the regular processing solutions, the films should be treated after washing in dilute Sodium Sulfite solutions or in dilute Ammonia solutions. The Chromium intensifier described earlier in this chapter, will regenerate the

dye-backing color of many films, but this color will again disappear during the redevelopment process of the intensification.

The use of desensitizers in tank development is advisable when there is uncertainty about the exposure, and when over-development is necessary in order to partially correct for under-exposure. Although over-development can not completely make up for under-exposure since it increases the contrast of the negative, it can be resorted to in order to get a printable negative from a gross under-exposure. By the use of a desensitizer, the development may be watched and stopped when the negative is strong enough to use so that further increase in contrast and grain will not be necessary.

Removing Negative Stains

Occasionally a film will acquire a stain due to developer oxidation products caused by insufficient sulphite or undue exposure of the developing solution to air. Sometimes this stain is caused by powder-form prepared developers which have been stored in a hot place for long periods. Such stains may be brown, pink, red, or purple, and because they absorb a great deal of light, they make the negative almost impossible to print. Films which have acquired such a stain should be hardened in the formalin-carbonate solution (p. 84), washed and then bleached in the following:

FILM STAIN REMOVER

Stock Solution A	*Metric*	*U. S. Units*
Water	1 liter	1 quart
Potassium Permanganate	5 grams	75 grains
Stock Solution B		
Cold Water	500 cc	16 ounces
Sodium Chloride	75 grams	2½ ounces
Sulphuric Acid (C.P.)	15 cc	½ ounce
Water to make	1 liter	1 quart

Note: The sulphuric acid must be added slowly with constant stirring, to avoid spattering of the solution which may burn the hands or face.

For use mix equal parts of A and B and immediately immerse the negative. Bleaching is usually complete in 3 to 4 minutes at 65° F. A brown manganese dioxide stain forms in the negative. This is removed by immersing the film in a solution of 10 grams (150 grains) of sodium bisulphite in a liter (quart) of water. The film is then exposed to bright daylight and re-developed in Edwal-126. The resulting image is somewhat grainier than the original, but it is free from stain. After re-developing completely (4 to 6 minutes) the film is washed for 20 minutes in running water, wiped off and dried.

WEIGHTS AND MEASURES

Weights

The avoirdupois system is used in weighing solids in the United States and the British Empire. The units of measurement are pounds, ounces and grains.

1 pound = 16 ounces = 7,000 grains
1 ounce = 437½ grains

The metric system is used in most European countries and their dependencies. The unit of weight is the gram.

1 kilogram = 1,000 grams = 1,000,000 milligrams

For converting from one system to the other:

1 gram	=	15.43	grains
1 kilogram	=	2.2	pounds
1 grain	=	0.065	grams
1 ounce	=	28.35	grams
1 pound	=	453.6	grams

Liquid Measure

The metric system is used in most European countries for all measurements of liquids. It is used in all countries for scientific work because it is uniform and easy to calculate from one unit to another. The units are the liter and the milliliter (commonly called the cubic centimeter). The abbreviations are l. for liter, ml. for milliliter, and cc for cubic centimeter.

1 liter = 1,000 ml. or 1,000 cc

The United States and Great Britain each has its own separate system of liquid measure. A U. S. gallon is not the same as a British Imperial gallon, a U. S. quart is not the same as a British quart, etc.

In the U. S. system:

1 gallon=4 quarts=128 fluid ounces=1024 fluid drams=3.785 liters

In the British system:

1 gallon=4 quarts=160 fluid ounces=1280 fluid drams=4.54 liters

For comparison between the three systems:

Metric		*U. S.*		*British*
1 liter	= 33.81	fluid ounces	= 35.20	fluid ounces
1 cc	= 0.2705	fluid drams	= 0.2816	fluid drams

Photographic Practice

Accurate conversion of formulas from one system to the other results in awkward numbers and fractions. For making up most photographic

solutions the fractions can be ignored. The common practice in the United States is to use the following approximate equivalents:

Weights

U. S. Units		*Metric*
15 grains	equivalent to	1 gram
1 ounce	equivalent to	30 grams
1 pound	equivalent to	450 grams
2.2 pounds	equivalent to	1 kilogram

Liquid Measure

1 fluid dram	equivalent to	3.7 cc
1 fluid ounce	equivalent to	30 cc
32 fluid ounces	equivalent to	1 liter
1 gallon	equivalent to	4 liters

Convenient Conversion Values

Many professional photographers convert formulas from Metric to U. S. Units and the reverse by using the following multiplying factors:

For Solids

Metric Grams per Liter × 14.6 = U. S. Grains per Quart
Metric Grams per Liter × 0.0334 = U. S. Ounces per Quart
U. S. Grains per Quart × 0.0685 = Metric Grams per Liter
U. S. Ounces per Quart × 29.96 = Metric Grams per Liter

For Liquids

Metric cc per liter × 0.032 = U. S. fluid ounces per Quart
U. S. fluid ounces per Quart × 31.25 = Metric cc per Liter

f-Numbers

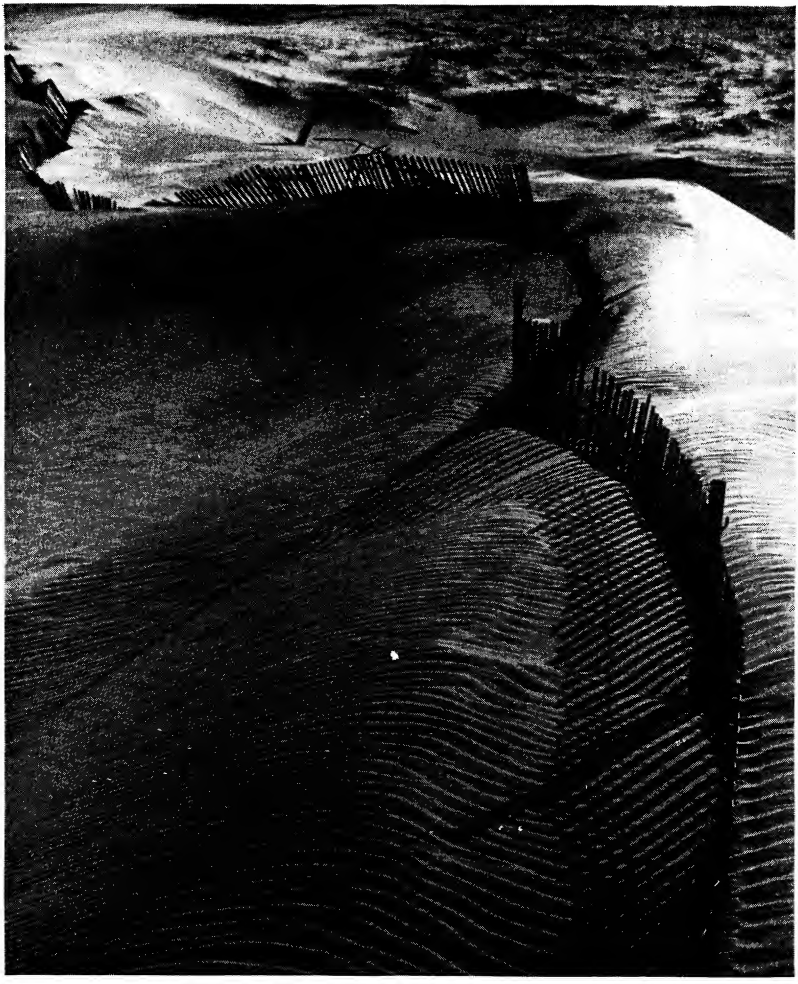
Different "systems" have been used to indicate the effective light-passing power or "speed" of a lens. The usual one is the *f*-system which is simply a ratio between the focal length of a lens and the apparent diameter at a particular diaphragm opening.

For instance, with a lens of a 4 inch focal length, a ½ inch diaphragm opening ("stop") will give *f*:8, while a 1 inch stop will give *f*:4.

While this system is in common use, the so-called "Uniform-System" (U. S.) was the basis of some lens markings. The two systems compare as follows:

COMPARISON BETWEEN *f* NUMBERS AND U. S. SYSTEM OF LENS STOPS

Relative Exposure required	1		2		4	8	16	32	64	128
f Number	4	4.5	5.6	6.3	8	11	16	22	32	45
U. S. Number	1	1.26	2	2½	4	8	16	32	64	128



"Dune Crest" *Hans Kaden*

From an Edwal-20 negative.

Chapter VII

WHICH DEVELOPER—AND WHEN AND WHY?

A chapter for the advanced amateur

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How Pictures are Classified

PICTURES are commonly classified as portraits, landscapes, still-life, etc., depending on the type of object of which the picture is an image. This is all right if you are looking at a picture or describing a picture or buying a picture—but if you are *making* the picture there are other classifications which will be much more useful. Thus, the experienced picture-maker learns to classify pictures according to tone, contrast, and range of detail.

There are for example warm-toned prints as opposed to cold-toned prints; there are contrasty pictures as opposed to soft or flat pictures; and there are pictures where detail is present from deepest shadow to brightest highlight, as opposed to others where shadow areas are blocked up so as to give bold masses of tone or where there are large, almost detail-less highlight areas. These methods of classification are most useful to the picture-maker, for they indicate the methods of processing that should be used. The photographer must first decide what type of picture will be most effective for the subject he wishes to represent. Then he can pick the film, the negative-developer, the printing paper and its developer in such a way as to give him the desired effect. Indeed, if he decides far enough in advance (most portrait and commercial photographers do) he can regulate the lighting of his subject. However, in outdoor work this is hard to do, and the vast majority of amateur pictures are taken under whatever lighting conditions nature happens to provide.

How Subjects are Classified

Instead of the common method of classifying various subjects as people, pigs, trees, mountains, etc., the photographer lumps all photographic subjects into three classes: brilliantly-lighted or contrasty; softly lighted or flat; and the in-between condition known as "average." There is sometimes a little confusion along this line because a subject may be brightly lighted and flat at the same time if there are no deep shadow areas. A common example of this is found in the photography of distant scenery where, though the sun is shining brightly, the haze in the air

reflects so much light that photographically there are no deep shadows and the picture is to all intents and purposes flat. Of course, filters can be used to cut the effects of the haze and help record on the film the desired contrast—but that is another matter.

Once the photographer knows the kind of picture he wants to make and the type of subject he has to make it from, he can pick out the best developing technique to use.

How Developers are Classified

There are, of course, fine grain developers, and the opposite; developers that give good gradations, and the opposite; fast-working developers, and the opposite—but the classification which is of most interest at this time is on the basis of contrast. There are the high-contrast developers (e.g. hydroquinone-caustic soda) which give little or no shadow detail and terrific highlight density and are used for copying line drawings or printed matter. No formulas strictly of this type are given in this book, though Edwal-12 can be made to give very strong contrast, if desired by increasing the Monazol content to 8 or 10 grams per liter as described in Chapter III.

Then there are the average-contrast developers which give a long tone scale, with detail and gradually increasing density from one end of the scale to the other. On flat subjects or with soft lightings, these developers can be made to "pep-up" the contrast when necessary by increasing the time of development. With average (not too bright) lighting these developers produce full-scale negatives which print well, especially on the chlorobromide papers. In the northern United States the outdoor light is usually of this "average" variety (except in mid-summer) and hence most of the developers used then are of the "average-contrast" or full scale type. Edwal-10, Edwal-12, and Edwal-20 are examples, though Edwal-20 is somewhat softer working than the other two, especially after it has been used for 2 or 3 rolls per quart.

With very brilliant light, or on contrasty subjects the "average-contrast" developers produce so long a tone scale on the negative that the printing paper cannot record it. As a result there is blocking-up in the darker areas or loss of detail in the lighter areas or both. This can be cured by under-developing the film so as to shorten the tone scale on the negative. This, however, compresses the tone scale throughout its entire length so that the middle tones tend to "run-together" so to speak. Also, under-development causes some loss of emulsion speed. These disadvantages can be avoided by the use of one of the third class of developers, the "soft-working" type.

A "soft-working" developer produces a shorter tone scale than the "average-contrast" variety, not by compressing the tone scale throughout its entire length, but by shortening the steps at the upper end. For those who enjoy curves and graphs, this is most easily shown by superimposing the H. & D. characteristic curves produced by an average contrast developer (A) and a soft working developer (B) on the same film. It will be seen that, with the "soft-working" developer, in the brightest areas (where exposure is great) a given increase in exposure produces a smaller difference in density than with the "average-contrast" developer, though in the middle tones the two solutions act very much alike. Thus detail throughout the entire range is retained because the tone scale of the negative never gets so long that a printing paper cannot record it.

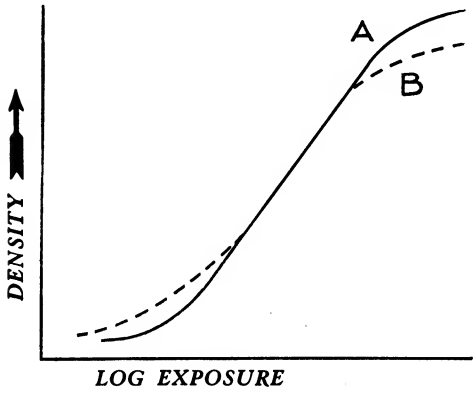

Fig. 13—Characteristic "H. & D." curves obtained by developing a film in (A) a full-scale developer such as Edwal-12 and (B) a soft-working developer such as Minicol.

Minicol, and to a lesser extent, Edwal-32, and Edwal-12 with the Monazol cut to 2 grams per liter are "soft-working" developers. These developers should be used in photographing contrasty subjects in brilliant light such as outdoor portraits in summer sunlight or most outdoor photography in southern United States and tropical countries. They are especially effective in photography of small near-by objects such as flowers, insects, rocks, and the like because over-development can be resorted to for emphasis of texture without losing detail through blocking up of the highlight areas. Of the developers mentioned, Minicol will give the finest grain, especially on the medium speed films. Edwal-32 runs a close second.

Specific Suggestions

It will be gathered from the foregoing discussion that generally speaking it is best to use an "average-contrast" developer with a soft or average-lighted subject, and a soft-working developer with a brilliant lighting. There are of course exceptions. Often, in stage photography for instance (where lighting is very contrasty) it is necessary to use a

full-scale developer in order to show detail in the highlighted areas and block-up or suppress unnecessary detail in the darker background areas. The photographer must plan ahead for the type of picture he wants and then use his judgment in picking the right developer. The beginner can follow the rules in the "cook-book" but as he makes more and more pictures he gains experience and can make his own rules. Different films give different degrees of contrast with the same developer, different printing papers can capture different amounts of detail, etc. Generally speaking a medium speed film (Finopan, Panatomic-X, Superior No. 2, or Plus-X) and a chlorobromide paper will give best results for all-round photography—but here again the expert makes his own rules.

The following are a few concrete suggestions as to film and paper developers for a number of specific photographic situations. These suggestions do not cover the entire field of photography by any means but they will demonstrate the method used in handling a given subject. The photographer can adapt the same method of thinking to other situations.

Landscapes in Northern or Western U. S.

In northern landscapes there are usually no very dark shadow areas and no unusually brilliant highlights, and on distant scenes there is often considerable haze. Hence, use an "average-contrast" or full-scale developer (e.g. Edwal-12 or Edwal-20) for the film and a general purpose developer such as Edwal-111 for the paper. A fast chlorobromide paper is usually satisfactory.

Landscapes in Southern U. S.

In southern or tropical light, any near-by shadows are usually very dark and highlights are bright. Hence a soft-working developer, e.g. Minicol, is suggested for the film. In regions such as Arizona and Southern California where the sun is usually bright and the air is very clear, Minicol can be used for any landscape, either near-by or distant. The landscape on Page 97 by Jack Powell is an example. On the other hand if haze is present and there are no large dark shadow areas, Edwal-12 and Edwal-20 are better for landscapes even in the tropics.

Close-Up Scenes in Bright Light

These include most summer snapshots, garden pictures, outdoor pictures of friends, or children, or pets. Usually the shadows are dark, and objects in direct sunlight are very bright. Hence, Minicol or Edwal-32, soft-working developers, are best for the negative. A medium speed film should be used. A fast chlorobromide paper is suggested for the print

"Tranquillity" *Jack Powell*

From a Minicol negative. Minicol can be used successfully on landscapes where there is little or no aerial haze. Where haze is present a full scale developer such as Edwal-12 or Edwal-20 is best.

with development in whichever paper developer provides the desired tone. A warm tone such as is obtained with Edwal-106 is often good on such scenes.

Close-Up Scenes in Soft Light

These include most winter scenes and outdoor pictures on dull, rainy, or hazy days. A full-scale developer, Edwal-12 or Edwal-20 is recommended and, if possible, a medium-speed "fine-grain" film. If the light is very soft, over-development by 10% or 20% helps the contrast, but should not be carried too far unless fine grain is not important. For snow scenes, etc., where delicate gradations are desired, Edwal-102 or Edwal-126 are recommended for the print, and one of the slow enlarging papers such as Indiatone or Opal, should be used. The print should be developed as fully as possible. Where delicate gradations are not vital, a fast chlorobromide paper and Edwal-110 or 111 are satisfactory.

Mustard Leaves *Jack Powell*

From a 35 mm negative developed in Minicol. This is typical of the texture that can be obtained by using Minicol on strongly lighted subjects.

Still Life

Some still life pictures of flowers, insects, rocks, machinery, etc., are lighted with brilliant oblique lighting so as to emphasize the surface texture. Such shots should be made on a medium speed film if possible and developed in Minicol or some other soft working developer. If it is desired to emphasize texture more strongly than is already done by the lighting, the film may be over-developed somewhat. Such pictures should always be printed on one of the slow enlarging papers to hold all possible detail. Edwal-126, Edwal-102 or Edwal-111 are suggested for print development.

Softly lighted still life shots are in a class by themselves. The developer to be used depends entirely on the kind of final picture that is desired. The film developer may be Minicol for soft effects, or Edwal-12 for a full scale negative. The paper developer should be Edwal-126 or Edwal-102 if delicate gradations are desired. There are, however, so many possibilities and so much depends on the whim of the maker, that no rules can be set up.

Stage Photography

This includes pictures of circus acrobats, night-club entertainers and all similar subjects where detail is wanted in a small brightly lighted area (usually illuminated with a spotlight), but where there are large areas of dimly lighted background where detail must be only suggested or must be actually suppressed. These pictures are usually made on the fastest film available and developed in Edwal-12, a full scale developer, producing maximum emulsion speed. For the print a bromide paper is suggested with full development in Edwal-120. If this combination suppresses too much background detail, use Edwal-111 or add more Orthazite to the Edwal-120.

Flash Photography

Flash negatives are usually extremely contrasty since objects close to the camera receive the greatest amount of light from the flash bulb. Soft working developers such as Edwal-32, or particularly Edwal Minicol are recommended for such subjects. Edwal Minicol is especially good since it will not block up highlights even on slight over-development. You may thus expose for the shadow areas and still not get the chalky faces so common in flash portraits and action shots.

Portraits of Children and Blonde Women

These are usually softly and evenly lighted so that there are no harsh shadows or lines. Because of this and because hair and eyebrows may need emphasis, especially in the case of children, the film should be fully developed in Edwal-12 or Edwal-20, full-scale developers. The print should be developed in Edwal-102 or 126, or if a warm tone is desired, in 106 or 108 developers. If any skin texture is to be shown a slow chlorobromide paper is best, otherwise a bromide or fast chlorobromide is satisfactory.

Brunettes

Brunettes are susceptible of more dramatic treatment, and rather contrasty lightings are often used in photographing them. Usually a full-scale developer is satisfactory, however, because lights can be placed so as to prevent loss of detail in shadows, and brilliant oblique lighting to emphasize skin texture is seldom employed.

Portraits of Men

The conventional type of man's portrait is usually handled in much the same way, as that of a brunette woman. However, in certain dramatic types of men's portraiture, brilliant oblique lighting is used to emphasize

character lines and skin texture. In such cases, the use of a soft-working developer such as Minicol is recommended for the film and Edwal-111 for the print.

Camera Technique

Users of miniature cameras often ask "How can I treat each subject in its own special way when I make 36 pictures on a roll and have several different kinds of pictures on a single strip?" The answer is "You can't." The present day fashion of shooting everything in sight on the fastest film available, developing for an arbitrary time in the newest developer on the market, printing on the cheapest paper developed in M.-Q. tubes is responsible for a great deal of very poor photography. It is as though a man owned one tool, a pick axe, and used it for digging a well, for cultivating his vegetable garden, and for playing golf. The pick axe is excellent for well digging and with experience could be used for golf or gardening, but no one will deny that the same man would do better at gardening if he used a hoe, and at golf if he used regular golf clubs.

The user of the 35 mm camera need not be discouraged, however. He can if he wishes load his own film in strips as long or as short as he pleases. He can shoot 10 or 20 negatives at a horse race or a track meet and develop the strip in Edwal-12, or shoot five full rolls in the mountains and develop in Edwal-20. The idea is to keep the film strips short enough so that the pictures on a single strip are all of the same subject, or at least of the same type. These can be developed in whatever manner is needed for best results with that type of subject. If several groups of pictures are taken on a *full* 35 mm roll, leaving a blank frame between groups of different subjects will make it easier to cut them apart (in the dark) to develop each group individually to its best advantage. To do this separating, rewind to the blank frame, as indicated by the exposure counter, open the camera (in the dark) and make a small cut in the film edge which can be felt in the dark and which will indicate where to cut the film apart when loading the film into the developing tank. Thus several groups can be taken on a single loading of film with less loss of film than using short lengths in separate cartridges. Before using this method, a few practice tries should be made (in the light) with a scrap roll of film or an unimportant developed roll in order to make sure that the indicating cuts actually fall within the "blank" frames.

Of course, all photographers do not attempt all kinds of photography, and the hobbyist who takes pictures of his friends, his pets, his vacation trips, etc., can usually get along pretty well most of the year with one developer, Edwal-12. For the summer season, however, if much outdoor picture taking is to be done (other than distant landscapes) Minicol would be better.

Chapter VIII

TONING

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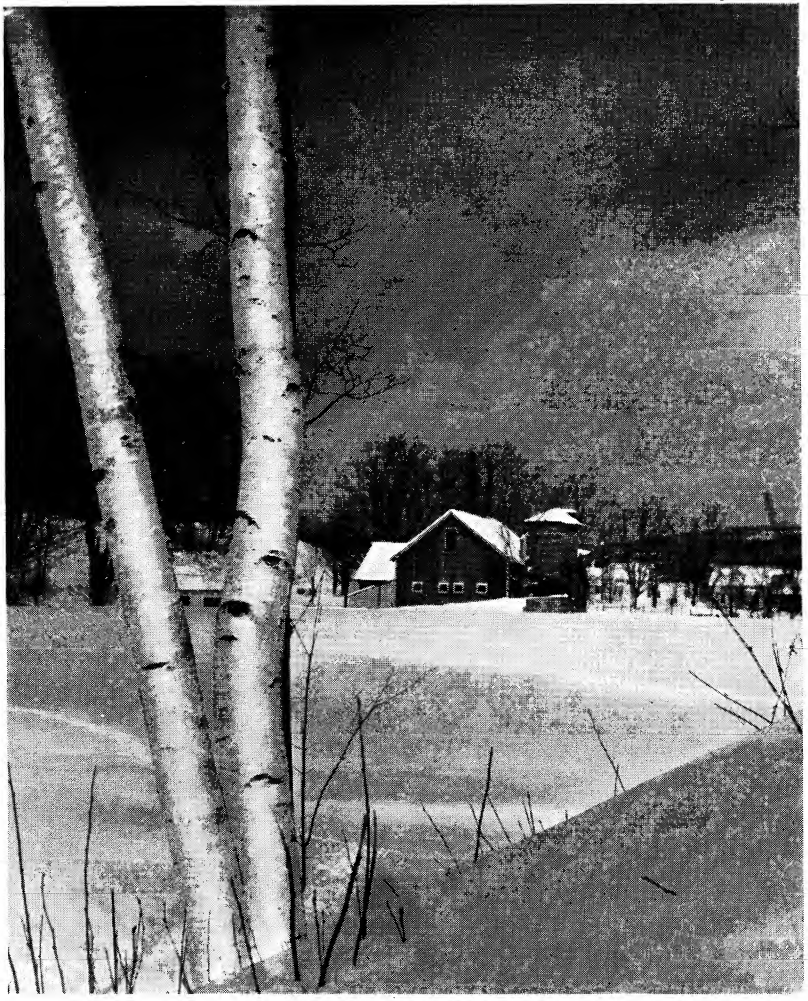
TONING is the substitution of some other color for the normal black of the silver image. It is generally used for esthetic purposes, to produce a more pleasing color or one which more nearly suits the mood of the picture. However, toning is also used in some cases to enhance the permanence of a print or to intensify the image. Thus, a sulphide toned print usually has a more stable image than the original silver print. Also negatives may be intensified by toning in Edwal Green Toner or Edwal Blue Toner, and prints may be somewhat intensified by toning in a Gold Toner in such a way as to produce a blue-black image and increase the contrast of the original picture.

Kinds of Toners

Toners are commonly classified either as "chemical" toners or as "dye-mordant" toners. Chemical toning usually consists of treating the silver image with a solution or a series of solutions containing chemicals which are not in themselves dyes, but which react with the image in such a way as to deposit colored substances in place of the original silver. Examples are sulphide toners which convert the silver image into silver sulphide having various shades of brown; the iron toners which substitute a blue image of ferric ferrocyanide; or the gold toners which deposit gold itself in various states of subdivision so as to produce images which range in color from blue, through purple, to red, depending on the manner in which the toning is done.

Dye toners (or to be more strictly accurate, dye-mordant toners) produce colored images by converting the silver image into a substance which will form an insoluble compound with the dye. The dye is thus "mordanted" onto the image and gives it its color. The Edwal dye toners are of this type. Such dye toners are relatively simple to prepare and use. They have the advantage that they can be mixed with each other to give intermediate colors, and since they can be made to work together, it is possible to tone adjacent areas of the same print with different toners and thus get a multi-colored print without any undesirable effects where the toners are mixed, as might be the case if "chemical" toners were used.



Ludlow, Vt. *Gustav Anderson*

Mr. Anderson's prints shown in this chapter are some of his famous snow-scapes which he frequently tones blue using a gold toner. He finds Edwal-106 and Quick-Fix without Hardener to be ideal for processing prints preparatory to toning.

Color Developers

Toning should not be confused with methods of color production which form the colored image directly during development. Toning means the production of a colored image by treating a regular black and white silver image with whatever chemicals are necessary to produce the color desired. Color developers on the other hand, produce a colored image during the developing process. With some of these developers, such as Edwal-106, the image consists of silver which has a brown or green, or other tone which depends on the particle size of the silver in the image. With other color developers known as "dye-couplers" the image is developed by means of a developing agent such as diethyl paraphenylenediamine which during the developing process is converted into a chemical which will "couple" with another chemical in the developer solution to form a dye. This dye deposits on the image and gives it its color. Quite a wide range of colors can be obtained through the use of various chemicals as "coupling components" and this method is the basis of color developing processes such as are used with Kodachrome and Anscocolor.

Each of the methods for producing colored images has its own uses and its own advantages and disadvantages. The toning processes are usually carried out in ordinary light so that it is easy for the user to judge when his prints have the colors he wants, and he can match one print with another with a reasonable degree of exactness without having to be more than usually careful about his procedure. Color developers, on the other hand, produce their colors during development under a safelight where it is hard to judge the exact tone. Exact tones can be obtained, however, and can be duplicated on print after print if the exact processing conditions (temperature, developing time and exposure) are determined through test strips and then are adhered to carefully in making every print. The production of colored images during development has the advantage that a print needs to be processed only once. The number of steps is considerably less than in the production of a toned print.

The colored images which are produced by developers such as Edwal-106 are useful not only because of the pleasing tones which are obtained, but also because the silver in the image is very finely divided which enables the production of very desirable colors when the print is later subjected to gold toning or other toning processes.

Because of their simplicity and ease of use the Edwal toners will be most fully discussed in this chapter. However, some of the more successful formulas of the "chemical" type are also given together with directions for their use.

Equipment and Supplies for Toning

The apparatus needed for toning is relatively simple. Usually some trays, graduates and print tongs are all that is necessary.

This apparatus should be clean and in good condition, since a foreign chemical getting into a toning solution may ruin its action entirely. Trays should be made of glass or enamel and if of the latter type should not be chipped. A chipped tray will contaminate the toner solution with small amounts of iron salts which produce blue spots or give an overall bluish cast to the print. Distilled water is strongly recommended for making all toning solutions if it can be had. If not, whatever water is used should be free of rust or other suspended impurities.

Choosing the Paper

Since the exact shade of color is affected by the type, brand, contrast and surface of the photographic paper chosen, several variations may have to be tried before the exact color desired is obtained. Examples of some of these variations are given in the table below for the Edwal Brown Toner. Similar variations will be found with other colors and other types of toners.

TABLE IV

Paper Name	All Prints on Contrast Grade 2 (Normal) Developed in Cold Tone Developers (As Edwal-110)	Neutral Tone Developers (as Edwal-102 or 111)	Warm Tone Developers (as Edwal-106)
Halo	Blue-Brown	Reddish-Brown	Red-Brown
Industro	Orange-Brown	Orange	Orange-Brown
Azo E	Dark Brown	*Light Brown	Red-Brown
Opal	*Chocolate Brown	*Orange Brown	*Red-Brown
Velour Black	Yellowish-Brown	Chocolate Brown	Reddish Brown
Halobrome	Chocolate Brown	*Chocolate Brown	Tan
Kodabromide	Light Brown	*Chocolate Brown	Dark Brown
Brovira	Dark Brown	*Dark Brown	Rotogravure Brown

**Most popular shades on these papers.*

With dye-mordant toners, the chlorobromide papers give the best colors. With sulfide and selenium toners, the slower chloride papers give more satisfactory colors. Since toners tend to increase the contrast of a print by adding color contrast to lighting contrast, rough surfaced papers are usually preferable and glossy papers are less frequently used. As will be seen by the table above, the choice of developer definitely affects the shade of color obtained.

HOW TO PROCESS A PRINT WHICH IS TO BE TONED

Exposure and Development:

Best results in toning are obtained from the use of prints which have been processed especially for toning purposes. A print should be exposed so that it can be developed fully, so as to have good tone separation and contrast. If variations in density are desired, these should be obtained by varying the exposure rather than the development. Thus if a light print is desired, it should be given a shorter exposure, and vice versa.

The print should be developed by time based on carefully made test strips or an exposure meter reading, rather than by inspection. This is especially true if it is desired to match colors in a number of prints. Care should be taken to avoid fog, whether this be due to "forcing" development for too long a time, or development too near a strong safelight, or the use of old or light-struck paper. Some toners give most pleasing results if the original print is developed in such a way as to produce a warm-toned image. In such cases a true "warm-tone" developer should be used, rather than attempting to get the desired tone through manipulation of the dilution or restrainer-content of a normally cold-tone developer.

Fixing and Washing:

Fixing should be complete but not overdone. The clearing time of the fixer should be tested as described in Chapter II and prints to be toned should be fixed the minimum time (twice the clearing time for a piece of test film). Overfixing makes it difficult to wash the emulsion free from chemicals before toning. Prints to be toned should be fixed in a non-hardening acid fixer. Most of the common fixer formulas are usable, provided the hardening chemicals are omitted. Edwal Quick-Fix and Edwal Acid-Fix are especially suited for fixing prints to be toned, since they are packaged with a Hardener in a separate compartment so that it can easily be omitted if desired.

Washing of the prints must be complete and uniform. The instructions given in Chapter II should be followed exactly. Prints to be toned should be handled individually in the wash water, or a mechanical washer or other device should be used so that there is no tendency for prints to stick together.

Drying, Retouching, etc.

Prints which are to be toned should be wiped free of surface moisture, using a sponge or other wiping device which has been washed completely free of chemicals. These prints should be dried in the open air, rather than between blotters, since even new blotters may contain some chemicals which can cause contamination. Old blotters which have previously been used for drying prints frequently have traces of hypo in

them. Glossly surface prints need not be ferrotyped, since they will be wetted again in the toner. They may, however, be ferrotyped after toning if this is desired.

If the print is too light or too dark for satisfactory toning, it is better to make a new print than to try to intensify or reduce it before toning. Retouching should not be attempted on the black and white prints before toning, since it will show up strongly in the toned prints. Retouching may, however, be done after toning is complete, by use of suitable dye solutions.

EDWAL TONERS

The Edwal Toners are, with one exception, of the dye-mordant type. The exception is the Blue Toner which is of the "chemical" type. All of them are packaged in a single solution to increase convenience in use.

The dye toners can be mixed with each other if desired. However, the Blue Toner being of the "chemical" type, should not be mixed with the dye toners. Several toners can be used in different areas of the same print in order to do multi-color toning, but the Blue Toner should not be allowed to mix with the others during such a procedure.

All the Edwal toners are "progressive" in that toning is a gradual process during which the color intensity builds up from a low value to a relatively high value so that the toning process can be stopped at any point when the desired shade has been reached.

How to Use Them:

Edwal Toners are diluted with water before use as described in the directions on the bottle label. To tone the print it is merely necessary to immerse it in the toning solution and leave it there with occasional agitation until the desired color is obtained. When toning is complete, the print is removed and washed in running water until the highlights are cleared of color. Best results are obtained if this wash water is at a temperature of 70° to 80°. If running water at that temperature is not available, washing may be done in several successive trays of water at the proper temperature.

The dilute toning bath, made by adding water to the stock solution, may be used to tone prints until toning takes longer than 15 minutes. At this point the solution should be discarded, as it is exhausted. The diluted toner is best used up immediately after it has been made. However, if desired, it can be stored in a full bottle for a few weeks. The toners keep better in the concentrated stock form than in the diluted

form, and hence, if only a few prints are to be toned, it is recommended that a relatively small amount of diluted solution be made up so that it can be used to full efficiency and then discarded.

If color from any of the toners should remain on the hands or processing apparatus, it may be removed by washing with soap and water. As has already been mentioned, these toners should not be handled in chipped enamel trays or in any other vessels containing exposed metal.

Multi-Color Toning

It is often desirable to tone one section of a print with one color and other sections with other colors. On large prints where there is room to work easily, very handsome effects can be obtained. In some commercial studios this method is used in producing natural color prints in preference to the laborious color separation method. The results obtained by Multi-color toning have been pronounced by experts to be superior in many cases to the prints produced by the color separation method. The toning method allows a very considerable degree of control of the exact shade desired, which is more difficult with other methods.

To do multi-colored toning the well-washed, limp print is swabbed free of surface moisture and laid on the bottom of a clean tray or a glass plate for treatment. Each color is applied individually to the particular area desired. When toning is complete in that area, the print is rinsed thoroughly before another color is applied to an adjacent area. After the entire print has been toned if it is desired to intensify certain sections, this can easily be done by applying additional toner, provided there is still some silver left in the image to induce further toning. When all the colors have been applied, the print should be washed sufficiently to completely free the highlights of all toner color.

Several toners may be applied successively in a particular area to obtain a blend. It is best to rinse the print briefly between applications of the different toners in this case, though this is not entirely necessary except when the Blue Toner is being used. If an area of the print is to be toned with several colors, including blue, the print must be washed thoroughly before and after the application of the Blue Toner since it does not mix well with the dye toners. If several toners are to be applied to the same area, care should be used to avoid toning too heavily with the first color; since these toners gradually remove the silver image and if all the silver is removed from any area no further toning will take place, and the second or third color applied may have no effect.

The toners are commonly applied with cotton swabs or brushes during the multi-color toning process. Any brushes used should be free from metal. If by accident a particular color tone goes beyond the area where it is desired, it may be locally removed by swabbing carefully with a 1% solution of sodium carbonate for the Blue Toner and a 1% solution of sodium bisulphite for the other colors. However, if the surface of the print is kept from excess water during the toning process, the spreading of the toners will be minimized and overlapping of colors prevented.

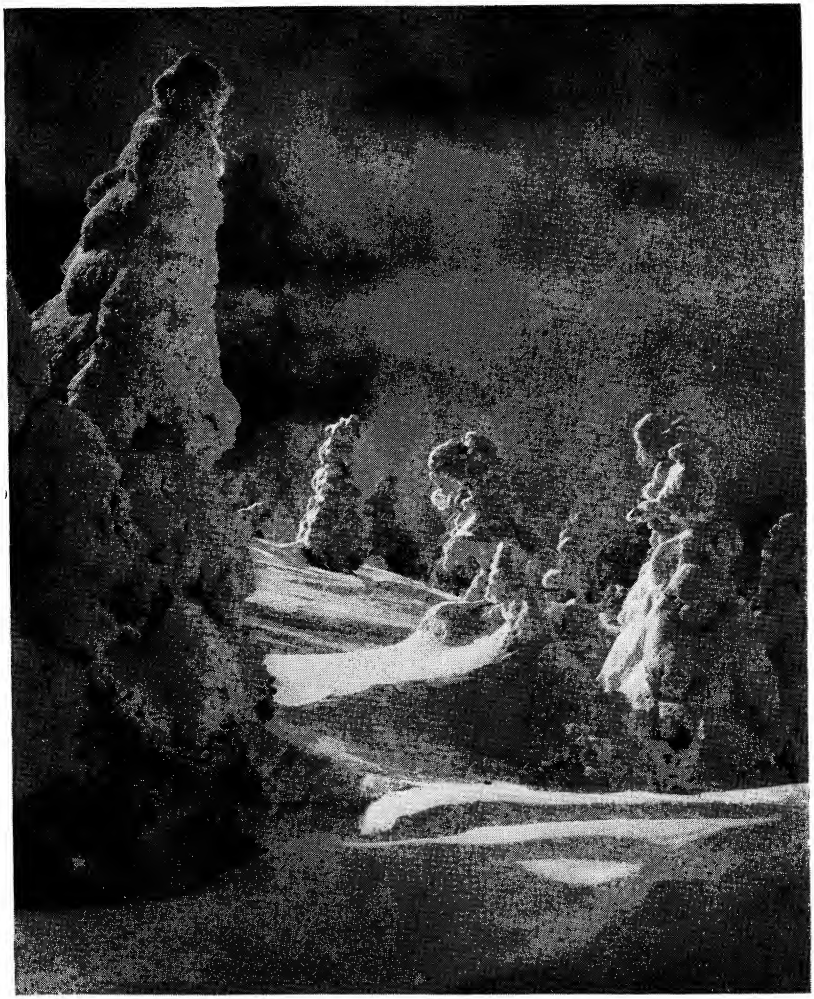
If mixtures of toning solutions are used, the exact shade obtained can to some extent be judged by the color during the toning process. However if this method is to be used for a large number of prints it is best to make up a fairly large volume of the toning solution mixture, which can be adjusted by adding small amounts of one toner or the other till the desired results are obtained on test strips. Then the entire batch of prints can be toned with this mixture, using the exact toning time which gave the best results on the test strip. The user will generally be able to get the tone desired after one or two trials. Flesh tones, for example, are obtained by mixing yellow and magenta toners for fair complexions and brown and magenta for darker complexions.

The colors produced by Edwal toners may be given a "lighter" appearance or made more transparent by removing the silver image completely after the toning process. This is done by toning the print to the desired color and then, after rinsing, immersing it in Farmer's Reducer (see Chapter VI) until no further loss of density in the image appears. The print should then be washed for about 15 minutes in running water to remove the Farmer's Reducer completely.

Prints which have been toned should be dried in the open air to avoid contact with blotters or other objects which deposit chemicals which could later change the color of the image. They may, if desired, be dried on heated print driers except for those prints which are blue toned.

Toning Movie Film

Single color toning of black and white movie film or of titles to be spliced into Kodachrome movies will give very pleasing results. The film which is to be toned should be soaked in clear water for 15 to 30 minutes to soften the emulsion, after which it is agitated in the toning bath, of the same strength as for prints, until the desired color is obtained. Film which has been excessively hardened in processing will be slow to tone, but will eventually take the color. If a protective lacquer has been applied to the emulsion surface, the film will not tone until the lacquer has been removed with a solvent. Information as to what solvent to use can usually be obtained from the film processing laboratory. If



"Solitude" *Gustav Anderson*

"I have just finished a batch of blue toned prints using your Quick-Fix without the Hardener and found it worked very well. They fixed in as short a time as 1½ minutes." *Gustav Anderson*

it is known in advance that the movie films are to be toned, the omission of this lacquer during processing can be requested, and it can be applied after toning if desired. The use of a non-hardening fixer for film which is to be toned is not as important as it is for prints.

Generally speaking, the same type of apparatus can be used for handling film during the toning process as is used for developing. However, it must be extremely clean and no metallic objects must be in contact with the film or the toner.

Intensification with Toners:

Any of the Edwal single solution toners may be used to intensify weak negatives, but the Green and Blue Toners seem to give best results. If these toners are used as intensifiers, the process should be watched carefully and toning stopped the moment the greatest depth of color is obtained, since if films remain in the solution too long, a large proportion of the silver image may be removed, leaving only the dye image. This may have a lower printing density than would have been obtained if only a small amount of toning has been applied to the original silver image.

If a negative has extreme contrast so that it is hard to print detail in the highlight areas, this situation can be remedied by toning the negatives in Edwal Blue Toner until all the silver image is removed. The blue image which results is more transparent in the denser areas than the silver was and the printing contrast of the negative is thereby somewhat reduced.

Toning Technique:

It has already been stated that the best results are obtained if the prints are developed and fixed with toning in mind. However, any print which has been developed, fixed and washed according to the best technique for making black and white prints, as described in the earlier chapters of this book, will tone satisfactorily. It should not be assumed from this, however, that all prints can be satisfactorily toned. A great number of prints are either under- or over-developed; over-fixed, often in worn out fixer; and improperly washed. These defects frequently cannot be detected by casual inspection of the prints. However, when toning is attempted unsatisfactory results are sure to be obtained, and the toning effort is a waste of time on such prints. The following paragraphs list some of the toning defects which may be encountered together with their causes:

Iron Spots—Iron in any of the processing solutions from chipped spots in enamel trays, or from rusty water supply pipes, or from water which

contains iron salts will result in blue spots on toned prints which may vary from bright blue spots to an overall bluish cast superimposed on the regular toner colors. If the print to be toned is suspected of having traces of iron rust or iron salts from the previous wash water, the rust can be removed while the emulsion is still wet by swabbing with wet cotton. Iron salts in the water can only be removed by re-washing with water which is known to be free from iron.

If a print has been washed in rusty water and dried, the rust particles may adhere firmly enough to prevent their being removed by swabbing. In such a case the rust may sometimes be removed by soaking the print in water and then swabbing the surface with a tuft of cotton which has been dipped in 5% Hydrochloric Acid. The print itself may be dipped in the acid if desired, but this is pretty rough treatment and the print should immediately be immersed in running water afterwards.

If, in spite of precautions, small blue iron spots appear on the toned print, they may sometimes be removed if they are not too dense by dipping a small brush in 1% Sodium Carbonate solution and painting the blue spots repeatedly with occasional rinsing until they disappear. The print should then be rinsed in running water for ten to fifteen minutes.

Color Fog—Fog which may be invisible in a black and white print will show up quite clearly when toned. Also a foggy-looking toned print may be obtained if the print has been insufficiently washed or over-fixed. Any condition during the developing and fixing of the print which would cause finely divided silver or the silver salt to remain in the emulsion will result in color fog when the print is toned, and because of this, prints which are to be toned should not be forced in the developer, should not be processed too close to the safelight, and should not be made on out-dated or light struck paper; all of which result in the formation of silver fog. Likewise, such prints should be fixed in a non-hardening fixer and should not be fixed too long so that the silver thiosulfate complexes are easily washed out. After fixing, the prints should of course be thoroughly washed in water which is not too cold, so as to remove all the soluble silver salts.

If fog has occurred while developing the print, toning may still be satisfactorily accomplished if the print is immersed in highly diluted Farmer's Reducer long enough to remove the fog before toning. The print should, of course, be thoroughly washed to remove the Farmer's Reducer before putting it in the toning bath.

Stained Highlights: Thorough washing will normally remove all toner colors from the highlights of a print which was properly fixed and washed before toning. If, however, the print was fixed in a hardening fixer, the hardening may affect the paper base of the print in such a way that it

will hold the toner dye. Thus, some color will appear in the highlight areas of the print. Such color can sometimes be removed from a print toned in Edwal Blue Toner by rinsing it for a few seconds in a 1% solution of Sodium Carbonate and then washing it in water. A 1% solution of Sodium Bisulfite will serve the same purpose for the clearing of highlight stains in dye toned prints in most instances. These clearing baths will also remove color fog in some cases.

Slow Toning: If a glossy ferrotype print is toned without removing the wax which may have adhered to it during the ferrotyping process, toning may be slow or may be uneven. In case a print is known to have ferrotype polish wax on it, this can be removed by rinsing the print with benzene or carbon tetrachloride, and then allowing it to drain thoroughly and dry. If the print has been over-hardened it will tone very slowly, in addition to giving colored highlights. This difficulty may be overcome sometimes by soaking the print for thirty minutes or more in water between 70° and 80° F. before toning.

If small amounts of hypo have been left in the print because of insufficient washing before toning, the print may refuse to tone at all, or may tone in some spots and not in others. If the amount of hypo in the print is appreciable, it may cause bleaching of some of the silver image. There is no remedy for these conditions once toning has been attempted.

EDWAL-MANSFIELD FOTOTINTS

Edwal-Mansfield Fototints are dyes which are used to add color to the clear portions or highlight areas of a film or print. Tinting is complementary to toning since it puts colors in the portion of the image that is not affected by the toner. Tinting is most used on transparencies such as movie films. However, a suitable application of tints will sometimes improve a toned paper print; for example, in the addition of colors to sunsets or sunrise scenes. Since tinting is merely the addition of a dye to the emulsion, it is not affected by the presence of hypo or other impurities in the film, and as a result films or prints may be tinted even though they contain silver salts or hypo which would prevent satisfactory toning.

The tinting of movie titles where the words are usually white against a dark background, not only adds interest through the introduction of color, but tend to cut down the glare which occurs where large letters are used. Tinting may be also used to provide a trace of color in a sequence such as a woods scene or sunset, where slight dimming of the clear highlights is an advantage. If tints are to be applied to selected

areas of toned prints, the tints should not be allowed to run over into the toned image portion, since this may degrade the toner color.

How to Use Fototints

The tinting process is exceedingly simple. Edwal-Mansfield Fototints are sold as concentrated stock solutions which are diluted with water in the proportion of a few drops per ounce of water, or one ounce of Fototint per gallon of water. The film to be tinted is merely soaked in the tinting bath with occasional agitation until the desired color is obtained. Care must be taken to be sure the tinting solution has free access to all parts of the emulsion. Vigorous agitation will speed the tinting process somewhat. If tinting proceeds too slowly, it may be speeded up by adding a quantity of 28% Acetic Acid exactly equal to the amount of Fototint concentrate which was added to the batch. Thus, an ounce of 28% Acetic Acid would be added to a solution containing an ounce of Fototint concentrate in a gallon of water.

The six colors of Fototints may be blended in any proportion to give intermediate colors, and the color of the bath will indicate the color which will be produced on the film. If the color obtained is deeper than desired, washing the film in running water will weaken it. If the color obtained is too light it is only necessary to return the film to the tinting solution until it is dark enough.

After tinting, films should be rinsed briefly in running water and hung up to dry. Drying will be speeded if the water rinse is followed with a rinse in a bath made up of a few drops of Edwal Kwik-Wet in a quart of water. The use of this wetting agent will cause the film to drain completely dry so that no water droplets adhere to the surface. The film may also be wiped free of surplus moisture with a viscose sponge if desired. A used Fototint bath which has not been completely exhausted may be stored between periods of use. However, if the diluted solution is kept for a long time mold is apt to grow in it, in which case it should be discarded.

CHEMICAL TONERS

While the Edwal dye toners are recommended for most work because of their simplicity of use, formulas and directions are given in the following pages for a number of "chemical" type toners for use by those who wish them. There are, of course, a great many toner formulas in the photographic literature. However, those selected for this chapter are standard toners which have given reliable results over a long period of time. The "chemical" toners are, in general, not compatible with each other and cannot be safely mixed to give intermediate colors, as can be done with the dye toners.

Toners for Brown (Sepia)

The standard chemical-type toners for brown are the hypo-alum bath and the indirect sulphide toners, all of which convert the silver image to silver sulphide.

HYPO-ALUM TONER

	Metric	*U. S. Units*
Solution A		
Water	2350 cc	2½ quarts
Hypo (Sodium Thiosulfate)	450 grams	1 pound
Solution B		
Water	30 cc	1 ounce
Silver Nitrate	1.3 grams	20 grains
Solution C		
Water	30 cc	1 ounce
Potassium Iodide	2.7 grams	80 grains

To Use: Add B to A with stirring, and then add C followed by 105 grams (3½ ounces) of Potassium Alum. The entire bath is then heated until the solution turns milky, indicating sulfurization. This usually requires boiling for a few minutes. If the precipitate is a dark gray instead of a light milky color, the toner has not been mixed correctly and will not be satisfactory.

Maintain the temperature at 110° to 125° F. during toning, which should take 20 to 60 minutes. If the temperature is lower, toning is slower, and often uneven and off-color.

When the desired color has been reached, remove the print from the bath, allow to cool, sponge it off to remove any scum, and wash thoroughly in running water. The print may be wiped or blotted dry but should not be dried completely between blotters, but in the open air—face up.

This toner may be bottled and reused later until toning is too slow. It must not be used in confined spaces, as the fumes are unpleasant and somewhat poisonous. They will also fog any film or photographic paper, even through the usual wrappings.

If the shade of brown from this process is not the one desired, the Indirect Sulphide method may be used.

Indirect Sulphide Toning

This is probably the most frequently used toning process in photography. The prints must be *thoroughly* washed before toning, and properly fixed before washing. Where fixing is not thorough, a brown or yellow stain forms in the toning bath. Residual hypo in a print com-

bines with the bleaching bath to form *Farmer's* Reducer, and some of the details in the highlights are bleached.

BLEACHING BATH FOR SULPHIDE TONER

	U. S. Units	*Metric*
Distilled Water	20 fluid oz.	1,000 cc
Potassium Bromide	175 grains	20 grams
Potassium Ferricyanide	263 grains	30 grams

Prints are agitated constantly in this solution until a yellow brown trace in the deepest shadows is all that is left of the image.

The bleached prints are washed until the wash water shows no discoloration and the yellowish tinge in the print has been removed. A re-developing or toning bath is then used and various colors may be produced.

RE-DEVELOPER FOR SEPIA TONES

	U. S. Units	*Metric*
Distilled Water	20 fluid oz.	1,000 cc
Sodium Sulphide Crystals	175 grains	20 grams
Selenium	4½ grains	0.5 gram

RE-DEVELOPER FOR BROWN TONES

Distilled Water	20 fluid oz.	1,000 cc
5% Thiocarbamide solution	4 fluid oz.	200 cc
10% Potassium Bromide	16 fluid oz.	800 cc
10% Caustic Soda solution	575 minims	60 cc

The toning takes between 1 and 1½ minutes, after which the prints must be thoroughly washed before drying.

The color of the final image may be varied by changing the composition of the bleach bath. The following variations in the formula will give the tones indicated though the exact color depends somewhat on the brand of paper being used.

Bleach for	*Warm Brown*	*Sepia Brown*	*Violet Brown*
Potassium Ferricyanide (10% solution)	60 parts	50 parts	30 parts
Potassium Bromide (10% solution)	4 parts	10 parts	50 parts
Ammonia (strong)	.....	.....	1 part
Distilled water	36 parts	40 parts	19 parts

Blue Iron Toner

The standard iron toner produces very brilliant blues. The black and white print, preferably of a somewhat softer than normal gradation and a trifle light (under-exposed) is toned directly in:

BLUE IRON TONER

	Metric	*U. S. Units*
Hot Distilled Water	500 cc	16 ounces
Ferric Ammonium Citrate	8 grams	120 grains
Potassium Ferricyanide	8 grams	120 grains
Acetic Acid, 28%	265 cc	9 fl. oz.
Distilled Water to make	1 liter	1 quart

The toned prints should be thoroughly washed in water that is not alkaline. The blue iron compound which makes up the colored image is soluble even in slightly alkaline solutions. Washing should be complete to remove any trace of the yellowish potassium ferricyanide which might otherwise remain. Maintaining a slight acidity of the wash water (in localities where it has a tendency to be alkaline) by occasionally adding a few cubic centimeters of acetic acid will give better washing. When washing is carried out under artificial light, the yellowish illumination is liable to cause the last traces of ferricyanide yellow to be missed until after the prints have been dried and viewed under daylight. Imperfectly washed prints have a sickly greenish character (yellowish in the highlights) which cannot be completely removed by further washing after drying.

The permanence of blue iron tones is limited by the extent to which all of the silver ferrocyanide formed during the toning operation has been converted to ferric ferrocyanide. Any silver ferrocyanide allowed to remain in the print may be reduced to metallic silver through the action of light or converted to sulfides of silver or otherwise reacted upon by chemical gases that may be present in the air. This usually results in the formation of a metallic or oily luster in some areas of the picture.

To completely eliminate silver ferrocyanide, the prints may be treated for a few minutes in the first of the following solutions, followed by a few minutes of retoning in the second solution and a final treatment in a 10% solution of hypo containing about 5% of boric acid.

Solution 1:

Potassium Ferricyanide	50 grams
Ammonium Hydroxide	50 cc
Distilled Water to make	1 liter

This treatment bleaches out the first formed image. It should be followed by a rinse and then treatment in Solution 2.

Solution 2:

Ferric Chloride	10 grams
Hydrochloric Acid	20 cc
Distilled Water to make	1 liter

The prints should be allowed to retone until the blue image is reformed. This treatment alters the shade of the tone and may not be satisfactory, so no valuable print should be treated in this way until experiment shows that the result is what is desired.

The Edwal Packaged Blue Toner is a stable modification of the basic iron toner. Being a stock solution, it is diluted with 16 parts of water for use; in other respects, the directions given above apply to its use.

GOLD-THIOCARBAMIDE TONER FOR BLUE

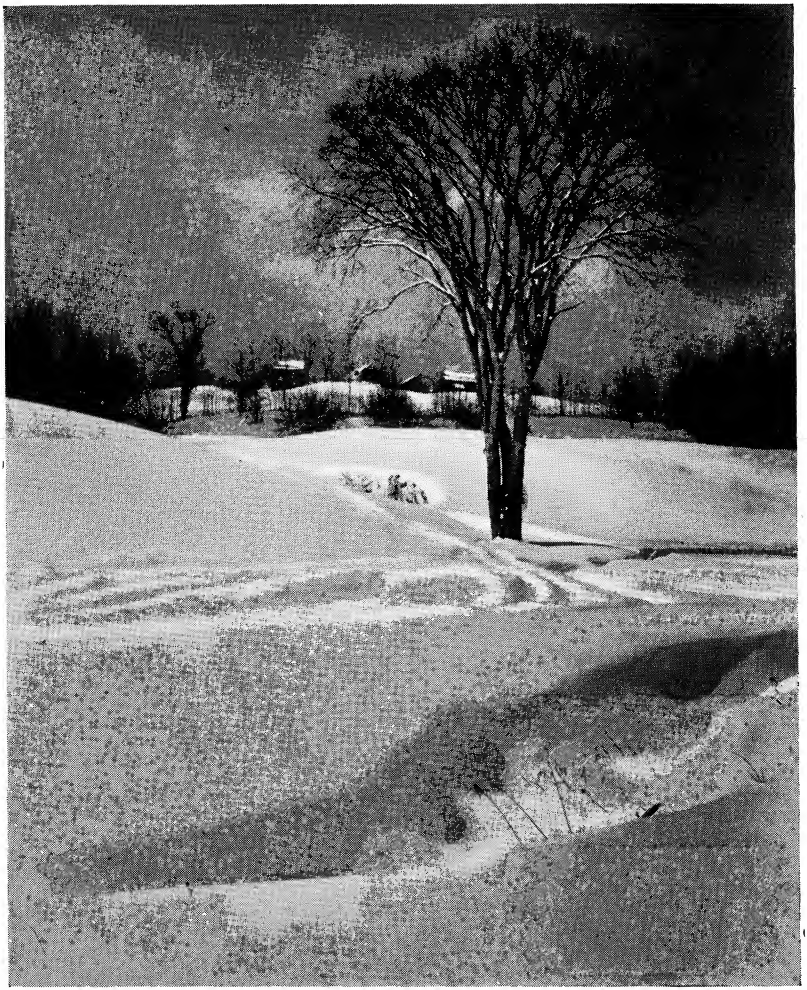
	Metric	*U. S. Units*
Solution A		
Distilled Water	**250 cc**	**8 fl. oz.**
Thiocarbamide (Thiourea)	**3 grams**	**45 grains**
Solution B		
Distilled Water	**250 cc**	**8 fl. oz.**
Citric Acid	**3 grams**	**45 grains**
Solution C		
Distilled Water	**250 cc**	**8 fl. oz.**
Gold chloride	**1 gram**	**15 grains**

For Use: Add equal parts of all three solutions to enough water to cover the prints in process. The amount of gold solution determines how many prints it will tone. One ounce (30 cc.) of each solution added to ten ounces of water will do three or four 11 × 14 prints, while adding the full 8 ounces (250 cc.) of each to a quart of water will give a convenient volume for larger prints, easily handling a dozen 14 × 17 prints. Additional water slows up toning.

This formula gives a variety of tones depending on the image color of the original print. Toning prints processed in metol-hydroquinone or Amidol (Edwal-126) developers results in a deep blue-black or purplish black tone, while prints processed in warm tone developers such as Edwal-106 give a lighter blue.

Gustav Anderson who uses this toner describes the following technique for processing his famous snow-scapes, such as the ones shown in this chapter:

". . . Vitava Opal and Illustrator's Special are my favorites for snow pictures as they give brilliant blue. For a more grayish blue, a bromide paper such as Kodabromide works very well using Edwal-106, especially for high-key subjects. For a normal negative on a chlorobromide paper, I dilute the Edwal-106 1:5, give about twice normal exposure and develop the print about 2/3 of normal, which means 4 to 5 minutes. The (black and white) print has more of a greenish than reddish color with this procedure. The print will tone to a deep blue with the darkest shadows almost black.



South of Woodstock, Vermont — *Gustav Anderson*

"For a brighter blue and also if the negative is more contrasty, I dilute from 1:7 to 1:10, depending on the subject. Exposure should then be from 3 to 4 times normal. Developing time will be from 5 to 8 minutes and the print will have a reddish color. Temperature of developer should be between 70° and 75° F. Prints should not be kept under the safelight during development as it is possible that a fog might develop during such long development. I turn the safelight off for the first 2 minutes, at least.

"Toning should be completed in from five to ten minutes. If prints are not toned by that time one or all of three things could be wrong: First . . . development was too long. Second . . . print was not properly fixed. Third . . . print insufficiently washed and retained hypo."

Deeper or purpler blues are obtained by gold-sulfocyanide toners such as the following:

GOLD SULFOCYANIDE TONER

	Metric	*U. S. Units*
Hot Distilled Water	**750 cc**	**24 fl. oz.**
Ammonium Sulfocyanide (Thiocyanate)	**105 grams**	**3½ ounces**
Gold Chloride (4% solution as in Thiocarbamate formula)	**150 cc**	**5 fl. oz.**
Water to make	**1 liter**	**1 quart**

Mix just before using and tone prints to desired color. Since this formula gives a very deep blue color, it is often used to make a neutral black print look "colder" by momentary toning which does not give a very apparent blue. This is also used as a protective solution, since this blue-black image is more permanent than the plain black silver image.

Red Tones

Chalk red tones are most easily obtained by toning a sepia print (resulting from use of a sulfide toner) in one of the gold toning solutions given above. The exact color depends to a great extent on the choice of paper, developer, and toners. In general, the more popular chalky reds result from gold toning a print which became a yellowish brown in the sepia toner. True sepia prints give a more full-bodied red by this method.

Copper toners produce red tones but the resulting image is not always stable. A gradual change sometimes occurs in which the image assumes a metallic glint unevenly over the surface, sometimes having an oily appearance. Copper toners may have a tendency to stain the whites and

highlights of the picture. In order to overcome this staining difficulty, it is best to use the solution only a few times, preferably once for each print, and as concentrated as recommended. A copper toning formula is:

	Metric Units	*U.S. Units*
Potassium Citrate	**18 grams**	**260 grains**
Copper Sulphate	**5.8 grams**	**85 grains**
Potassium Ferricyanide	**4.3 grams**	**63 grains**
Ammonium Carbonate	**1.4 grams**	**20 grains**
Distilled Water to make	**1 liter**	**1 quart**

It will save weighing to make up 10% solutions of each of these solutions and then measure out portions corresponding to the amounts of chemical required in a graduated cylinder. Thus, 180 cc. of 10% potassium citrate would equal 18 grams of the solid chemical.

The copper tone may be rendered more brilliant and at the same time more permanent by treating the toned print in the following solution which converts any silver ferrocyanide to copper ferrocyanide leaving silver chloride:

	Metric Units	*U. S. Units*
Copper Sulphate	**50 grams**	**1 2/3 oz.**
Sodium Chloride	**20 grams**	**2/3 oz.**
Distilled Water to make	**1 liter**	**1 quart**
Hydrochloric Acid	**10 cc**	**1/3 fl. oz.**

Following this treatment, the print would be fixed in a 10% solution of hypo containing 5% of boric acid, in order to dissolve the remaining silver chloride. This should be followed by a thorough washing to remove the fixing solution.

Green Tones

Green tones by direct chemical toning methods give very brilliant greens, not suitable to landscapes. The following vanadium toner can be used where this brilliant green type of tone is desired. For landscapes darker greens can be obtained through the use of Edwal blue and green toners successively.

VANADIUM GREEN TONER

		U. S. Units	*Metric*
A)	**Ferric Chloride**	**8 grains**	**1/2 gram**
	Oxalic Acid (saturated solution)	**1 fl. oz.**	**30 cc**
	Vanadium Chloride	**16 grains**	**1 gram**
	Nitric Acid	**1/12 fl. oz.**	**2½ cc**
	Distilled Water to make	**4 oz.**	**120 cc**
B)	**Potassium Ferricyanide**	**40 grains**	**3 grams**
	Distilled Water	**4 oz.**	**130 cc**

Add B to A (not the reverse) with constant stirring. If toning does not take place in one to three minutes add 1 to 5 grains more of the ferricyanide, depending on the paper used.

The longer the toning, the brighter the green. Stop when the desired shade is attained, and wash until the blue tinge is gone. Then fix about 10 minutes in:

HYPO-BORAX FIXER

	U. S. Units	*Metric*
Water (warm)	**16 ounces**	**500 cc**
Borax	**320 grains**	**22 grams**
Hypo	**3 ounces**	**100 grams**

The hypo should not be added until all the borax is dissolved and the solution cooled to 70° - 75° F.

Wash for 20 to 30 minutes after fixing.

Chapter IX

RESULTS

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EVERYONE who has chosen photography as a hobby, or who uses it to make a living, naturally wants to know what results he may expect from Edwal chemicals.

Here the best measure of satisfaction is found in the pictures made with Edwal developers and the testimony of amateur and professional photographers who use them. On the following pages are a few unsolicited statements from Edwal users. Some of them are from professionals whose pictures illustrate national magazines, others from pictorialists whose prints hang in many salons, but the ones we value most are from the amateurs who find that Edwal chemicals and methods give them better pictures of their vacation trips, friends, and children.

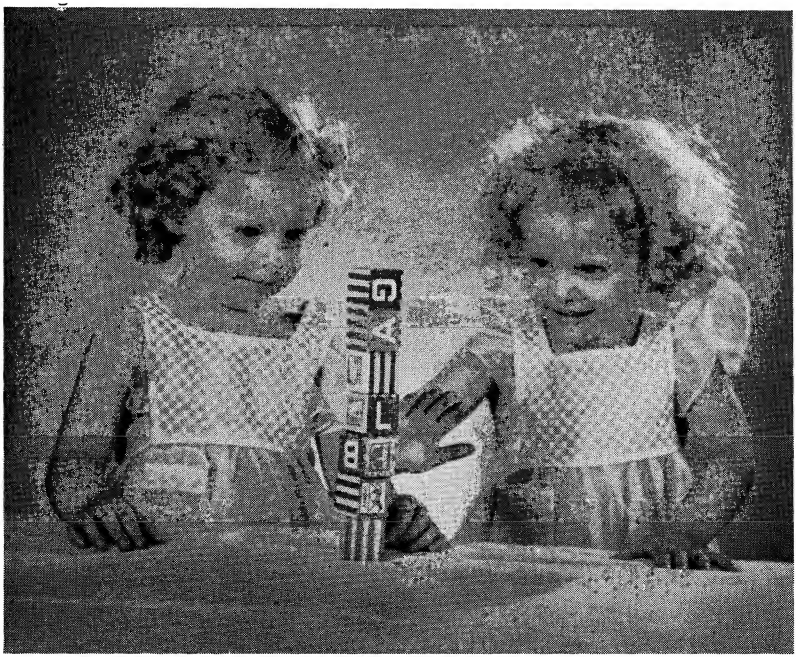
"I am more and more pleased with Quick-Fix. I get three tanks fine-grain developed, fixed, and washed in a half hour. . . . I hate waiting in the dark for hypo."

Rowena Fruth, A.P.S.A.

One of America's foremost Pictorialists. Holder of first place in the American Annual of Photography listing of most prolific Salon Exhibitors for 1944.

Mrs. Fruth is a director and associate of the Photographic Society of America. She became interested in photography "because Virgil (her husband, Dr. Virgil J. Fruth) bought himself a Contax . . . and I thought I would like to see how it worked." She studied at the Haz-Sanders school of photography and soon began sending prints to salons. Her first published print was in the 1941 U. S. Camera Annual and was from an Edwal-20 negative.

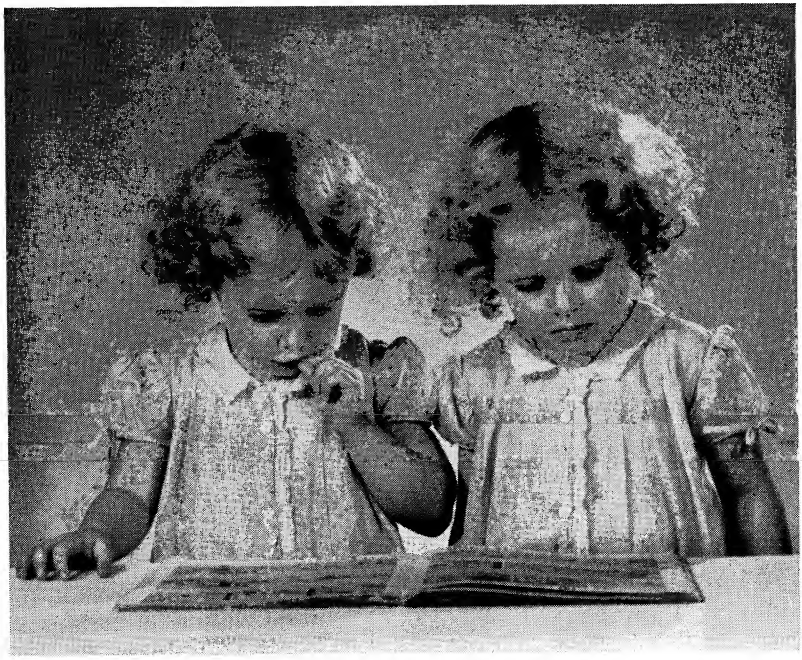
Mrs. Fruth's accomplishments since that time have established her



"I Dare You!" *Rowena Fruth*

firmly in the "who's who" among pictorialists. She received 10th place in the American Annual's "prolific exhibitors" listing in 1942, 2nd place in 1943, and first place in 1944. She has had one-man shows at Smithsonian Institute, Brooklyn Museum of Arts and Sciences, and various camera clubs. She has judged Salons in Toledo, Cincinnati, Muncie, Dayton, New York, Oklahoma City, Detroit and others; and has appeared before some of the most prominent Camera Clubs in the country.

Such a list of honors and achievements (there are others that could be



Consternation **Rowena Fruth**

added if we had space to recite them) is of course the result of much work, great skill, and artistic ability—but we are proud to have produced some of the chemical "tools" that helped accomplish it. When asked whether she used any special methods when developing in Edwal-20, Mrs. Fruth replied "Nothing special—I just do what it says in the direction sheet,"—which we consider a compliment to the thoroughness of the photo chemists who work out and standardize Edwal methods.

Magic *Rowena Fruth*

The prints shown here were developed in Edwal-102 which is especially intended for reproducing the delicate gradations that are needed in women's and children's portraits, high key pictures, etc. The photography of children from babyhood up is one of the most rewarding of pastimes, and the combination of Edwal-20 for the negative and Edwal-102 for the print can produce unexcelled results in it.

What Others Say—

These comments on Edwal Products came to us unsolicited, from actual users. We do not buy "testimonials."

"I have used 'Edwal-20' exclusively for the past five years since I have found same to be ideal for my requirements. . . . The resulting prints from my negatives are usually excellent and dozens of same (14 x 17) have been hung in salons."—H. W. F., F.R.P.S. Vancouver, Canada

This Edwal user is a Fellow of the Royal Photographic Society and does not make hasty decisions about a film developer.

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"I appreciate the conservative manner in which you discuss your formulae and products. It is a very welcome relief to read the discussions in the book, try them out and find that they work as described and that one does not need to subtract 50% for artificial bombast. Edwal-12 proves most useful to me for film and the Edwal-102 is the lantern slide *superb* developer. I process approximately 2500 to 3000 slides per year."— G. E. M., Photo Dept. C.G. Hospital, Denver, Colorado.

Edwal products stand up under the exacting requirements of hospital technicians.

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"I am now a 6 x 6 cms. user, and use Plenachrome and Superpan Press, and by developing and exposing according to your instructions I obtain beautiful qualities in my negatives, despite the fact that they are thin looking. Enlarged on No. 3 grade papers I have secured pictures of excellent gradation."—Lieut. A.C.G., R.C.A.F. Calgary, Alta., Canada.

Lieut. G. is a member of the Royal Canadian Air Force and has been getting some excellent results with Thermo-Fine on cloud and mountain shots in the Canadian Rockies.

"For sometime now I have been giving your developers a real going over, and I am happy to announce to you that they are going to be my standard in the darkroom and I honestly believe that there are no better developers than your Edwal-12, 20, 102 and 111. Each had a fair chance alongside of other developers in my laboratory and they have found a home which shall be theirs for a long time to come."—J. V. K., Marblehead, Ohio.

With five film developers and two print developers, photographers may choose Edwal formulas best suited to their particular needs.

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"The winner of the book (Modern Developing Methods) which you donated last year has become one of our best workers."—R. S., Sec'y. B. H. S. Photography Club, Brooklyn, New York.

Good photographic manuals are always an aid to better darkroom technique.

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"Since Christmas I have been using your Mansfield Color Toners and am very satisfied with the results I have obtained."—F. F., Weehawken, N. J.

Many black-and-white prints reveal hidden beauty when color-toned.

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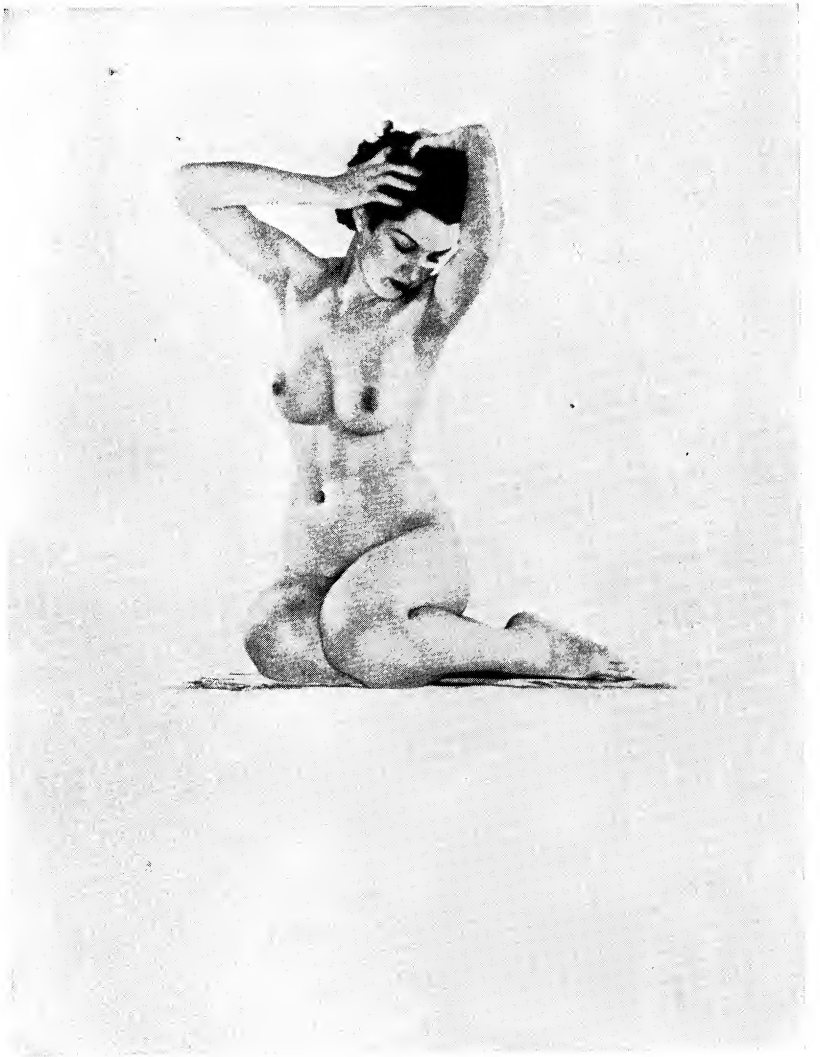
"I have been using Edwal-12 now for more than a year, and if you should ever need an additional testimonial to its merits, I would be very happy to sing its praises."—C. L. L., Ph.D., San Francisco, California.

Ph. D. means Doctor of Philosophy (in case you didn't know) and means that Mr. L. has successfully completed at least 3 years of post graduate study and has done original research, hence we are doubly complimented by his opinion of Edwal-12.



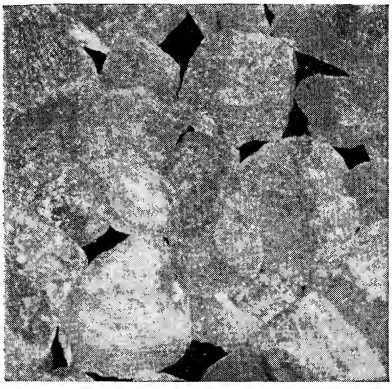
"Jeunesse" *Jack Powell*

From a 35 mm. negative developed in Minicol.

EDWAL PHOTO PRODUCTS

Edwal Pure Chemicals

The units in which Edwal pure photo-chemicals are commonly marketed are listed here, together with prices. Prices on larger quantities may be had on request. All the developing agents are packed in amber, screw cap bottles. The alkalis and Fine Grain Sulphite are packed in cans. The formulas given in this book are specifically designed for Edwal chemicals. The use of other brands of chemicals may produce results entirely different from those specified here.



These are crystals of purified Diamine-P before being ground and packed in bottles. Diamine-P is the purest paraphenylenediamine that can be made

IF YOU MIX YOUR OWN SOLUTIONS

Insure dependable results by using the same pure chemicals from which Edwal Prepared Developers are compounded. They may be purchased from your photographic dealer.

EDWAL PHOTO-PURE CHEMICALS

AMIDOL (diaminophenol dihydrochloride) 1 oz.; 4 oz.; 1 lb.
CATECHOL (pyrocatechin, C. P.) 1 oz.; 4 oz.; 1 lb.
C. H. Q. (chlorohydroquinone) 1 oz.; 4 oz.; 1 lb.
DIAMINE-P (pure paraphenylenediamine) 1 oz.; 4 oz.; 1 lb.
GRADOL 1 oz.; 4 oz.; 1 lb.
METOL (monomethyl para-aminophenol sulphate) 1 oz.; 4 oz.; 1 lb.
MONAZOL (photographic glycin) 1 oz.; 4 oz.; 1 lb.
ORTHAMINE (Orthophenylenediamine) 1 oz.; 4 oz.; 1 lb.
POTASSIUM CARBONATE (anhydrous) 1 lb.
FINE GRAIN SULPHITE (pH controlled for fine grain work) 1 lb.; 5 lb.
EDWAL T. S. P. (Trisodium Phosphate monohydrate) 1 lb.; 4 lb.
THIAMATE (non-hypo high-speed fixing agent) 6 oz.; 1½ lb.

EDWAL PREPARED DEVELOPERS

For those who wish to buy their developers ready-mixed the most popular of the Edwal formulas are marketed in prepared form.

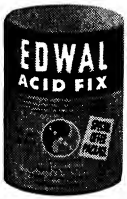
FINE GRAIN FILM DEVELOPERS

Edwal-12 (powder) ..... 1 Qt. Size
Super-12 (liquid) ..... 1 Qt.
Edwal-20 (powder) ..... 1 Qt. Size
Super-20 (liquid) ..... 1 Qt.
Edwal-20 High Energy Replenisher (powder) ..... 1 Qt. Size
Minicol (powder) ..... 1 Qt. Size
Minicol (liquid) ..... 1 Qt.
Thermo-Fine Tube Developer (powder) ..... 1 Qt. Size
Micrograin-85 (powder) ..... 1 Qt. Size
Micrograin-85 (liquid) ..... 1 Qt.

PRINT DEVELOPERS

Edwal-102 (liquid)
Pint makes 5 pints of working solution.
Quart makes 5 quarts of working solution.
Edwal-111 (liquid)
Pint makes 5-8 pints of working solution.
Quart makes 5-8 quarts of working solution.
Gallon makes 5-8 gallons of working solution.
Edwal-111 (powder) makes up to ½ gal. working solution.

EDWAL FIXERS AND HARDENER



Edwal Acid Fix

Edwal Acid Fix, once it is dissolved, is as stable as it is possible to make a solution of this type. When kept in a cool place it can be stored for quite long periods and can be used over and over until exhausted. It is so compounded that there is less tendency to precipitation than with the ordinary acid-hypo-alum bath. Indeed, developers which contain trisodium phosphate, which causes a precipitate in ordinary fixers, can actually be poured into Edwal Acid Fix solution without precipitation.

Half Gallon Carton

Edwal Liquid Fix

Edwal Liquid Fix is a convenient concentrated, standard speed, acid hardening fixer designed for those who prefer not to mix their own powders. Easy to make up small fresh batches for every darkroom session if needed. It is highly stable and is not affected by freezing or by storage at 150° F. for many weeks.

Qt. bottle (makes 1 gal. fixer)

Edwal Quick-Fix

Edwal Quick-Fix is a stable high-speed acid hardening fixer which will clear most films in one minute or less, and which will completely fix and harden a negative in 3 minutes. Some films will be fixed in 2 minutes, but unless extreme speed is needed, a 3 minute fixing time is preferable.

Quick-Fix contains a new fixing agent—Thiamate—which has three times the fixing power of hypo. Because of its extreme speed of fixing, Quick-Fix will save many hours of processing time for both amateur and professional photographers, and its introduction in 1940 marked a real step forward in negative making.

The exact amount of film that can be fixed varies with the emulsion and the amount of undeveloped silver bromide in it. However, in laboratory tests 10,000 square inches of exposed film (equal to more than two hundred and eighty 5 x 7 negatives) was fixed in a gallon of Quick-Fix ("high speed" dilution, made from a quart of Quick-Fix concentrate) before the clearing time became longer than 2 minutes, and an additional 10,000 square inches of film was fixed before the clearing time had increased to 7 minutes.

It may also be used for prints, if they are promptly removed from the fixer after *two* or *three* minutes immersion. Fading will occur if the print remains in the fixer for a long time, because the smaller silver grains are oxidized by air dissolved in the liquid or held in the paper base, and this oxidized silver is quickly removed by the powerful solvent action of Quick-Fix.

For ordinary fixing of prints (or for negatives where high speed is not desired) one quart of Quick-Fix concentrate is diluted to make 2 *gallons* rather than one gallon. In this diluted form the working solution is equivalent in strength to a standard fixer, such as Edwal Liquid Fix or Acid Fix. In this "standard-strength" dilution, film should be fixed for 15 to 20 minutes, and paper for 10 minutes.

1 Qt. (makes 1 gal.); 3 Qt. (makes 3 gals.); 5 Qt. (makes 5 gals.)

New Improved Edwal Chrome Hardener

This New Improved Edwal Chrome Hardener now contains Edwal Therm~Salt, an inert chemical which prevents the film emulsion from swelling before the hardening action commences. It is especially useful in hot weather processing since films may be washed in warm water if necessary without undue softening. When dry, such films will resist scratching and abrasions during subsequent manipulation.

1-lb can makes 12 pints hardener

OTHER EDWAL PHOTO SPECIALTIES

Edwal Color Toners

These single solution dye toners color the silver image and allow the highlights to wash out clear in black and white prints and movie film. Six permanent colors allow a wide variety of intermediate shades since control is achieved by length of immersion or concentration of the dye toner in the bath or even by blending one or more colors. Works with all types of paper and no bleach or after treatment is necessary.

3-ounce bottle

Kit of four colors, 3-ounce size

(Available in Blue, Brown, Green, Magenta, Red, Yellow)

Edwal (Mansfield) Fototints

As its name implies Fototints will tint the highlights of black and white prints and movie film while the black silver image remains unchanged. It may thus be used on prints and movie film which have previously been toned in order to add color to the highlight area which is not affected by toning. Fototints are particularly useful as an economy measure for making colored titles from black and white movie film which may be spliced into Kodachrome movies.

1-oz. bottles (enough for several hundred feet of movie film)

(Available in six colors: Fire Red, Sapphire Blue, Emerald Green, Amber Brown, Royal Purple and Sunlit Yellow)

Edwal Ferrotype Polish

Edwal Ferrotype Polish is made with easy-polishing waxes that require a minimum of rubbing. The solvents used are balanced so as to make it rapid drying. It insures the production of brilliant glossy prints, free from surface defects.

4 oz. bottle; gallon bottle

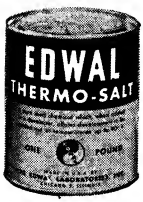
Edwal Film Cleaner

Edwal Film Cleaner removes grease spots, fingerprints, watermarks, dust from films, slides, negative holders. It prevents accumulation of static charges which cause dust to stick to film or glass. **4 oz. bottle; gallon bottle**

Edwal COLOR FILM Cleaner

Especially designed for cleaning color movies, color transparencies, and color prints. Will not degrade colors or affect lacquer in any way.

4 oz. bottle; gallon bottle



Edwal Thermo-Salt —For Hot Weather Development

Thermo-Salt is a pure inert chemical which when added to the developer prevents excessive swelling of the gelatin. Because of this it allows development with any developer (except those containing caustic soda) at temperatures up to 85° and with fine grain developers up to 90° F. It is not a hardener and it does not affect the developing power except that, since the gelatin does not swell, diffusion of the developer through the emulsion is somewhat slower and development is prolonged about 20% at temperatures below 75°. Thermo-Salt is especially recommended for use with print developers, because it cuts down the tendency to staining and prevents blocked-up shadow areas at high temperatures. Each can contains a scoop which measures the correct amount for 1 pint of solution. One pound treats 18 pints of developer. No weighing is necessary. Complete directions will be found on the label of each Thermo-Salt can.

1 lb. can; 5 lb. can

Orthazite—For cold Blue-Black Tones on Prints

Orthazite is a chemical which restrains development and prevents fog. At the same time it causes the production of cold bluish-black tones on prints instead of the greenish blacks which are often obtained when potassium bromide is used as a restrainer. It gives the coldest tones with developers of the metol-hydroquinone, or better, the metol-C.H.Q. type such as Edwal-110. Its most pronounced effect on tones is obtained with the chloride papers; less effect is produced with chloro-bromides and still less with bromides. It often makes the use of out-dated paper entirely satisfactory.

Orthazite prolongs the useful life of the developer somewhat because of its strong anti-staining action. It also allows greater latitude of developing time without the production of stains. It is especially recommended for copy process because of the dense blacks and clear whites that can be obtained. One ounce is sufficient for 20 to 40 gallons of developer. **1 oz.; 4 oz.; 1 lb.; 5 lb.**

Edwal Signal Shortstop

Signal is an acid for photographic use. It contains an indicator which signals the exhaustion of the acidity in the solution by changing from a yellowish color when the solution is still acid to a purplish color when the solution loses its acidity. The color-change is easily visible under an amber safelight. It is equal in strength to 28% Acetic Acid, and may be used wherever Acetic Acid is called for in photographic formulas. The pint bottle is sufficient for making 32 pints of Shortstop since only a half ounce is required to each pint of water. Ten drops of Signal to a quart of water is sufficient for a rinse-bath for fine grain film.

Pint bottle (enough to make 32 pints of Shortstop)

Edwal Shortstop, Anhydrous

Stops development instantly on both films and paper and neutralizes the alkalinity which exhausts the fixer. This results in a longer fixer life and prevents spots and stains due to uneven coverage with fixer. Makes 5 quarts of Shortstop for ordinary film and paper.

5 Quart Size Can

Edwal Kwik-Wet

This is a super-concentrated wetting agent which when added to the final rinse cuts drying time of film in half and eliminates water spots. When it is added to any film developer it prevents airbell pinholes. It promotes rapid coverage and even development when added to any paper developer. A speedier and more thorough job of fixing can also be achieved by adding it to the fixing bath.

½ ounce bottle (enough to treat 85 pints of photographic solutions)

Edwal Hypo-Check

An extremely easy test for wornout hypo. A milky precipitate will form in wornout hypo when a few drops of Hypo-Chek is shaken into it. If the hypo is still usable no change takes place whatever.

½ ounce bottle (enough for making 225 tests)

Edwal Photo-Chem Kit

All the chemicals necessary to develop and print your own pictures—complete with a copy of "Modern Developing Methods." Contains: 1 qt. Edwal-12, ½ gal. size Edwal-111, Shortstop, Acid-Fix, Hypo-Chek and Thermo-Salt.

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Price List

EDWAL PHOTO PRODUCTS

Ready-Mixed Developers

LIQUID FORM	Pint	Quart	Gallon
EDWAL SUPER-12		$1.35	$3.95
EDWAL SUPER-20		1.35	3.95
MINICOL		1.35	3.95
MICROGRAIN-85		1.35	
EDWAL-102 (Stock Solution)	$0.85	1.35	
EDWAL-111 (Stock Solution)	.85	1.35	3.95

POWDER FORM	Quart Size
EDWAL-12	$0.85
EDWAL-20	.85
EDWAL-20 HIGH ENERGY REPLENISHER	.85
MINICOL	.95
MICROGRAIN-85	.85
EDWAL THERMO-FINE	.35
EDWAL-111 (Makes Half Gallon Working Solution)	.35

Fixers and Hardeners

EDWAL QUICK-FIX	
1 Quart Bottle, dilutes to make 1 gallon	$1.25
3 Quart Bottle, dilutes to make 3 gallons	3.50
5 Quart Bottle, dilutes to make 5 gallons	4.75
(Special Hardening Solution *INCLUDED* in each package.)	
EDWAL LIQUID FIX	
1 Quart Bottle (dilutes to make 1 gallon)	.75
EDWAL ACID FIX (Powder) Makes ½ gallon	.30
EDWAL CHROME HARDENER	
Makes 12 pints hardener	.60

Photo Chemical Specialties

EDWAL COLOR TONERS (6 colors) ..... 3 oz. bottle $0.65
12 oz. bottle 1.25

Colors: Blue, Brown, Green, Magenta, Red, Yellow.

EDWAL COLOR TONER KIT (4 bottles) ..... Per Kit 2.45

Colors in Kit: Blue, Brown, Green, Magenta.

EDWAL FOTOTINTS (6 colors) Shaker-top bottle ..... .45

Colors: Blue, Brown, Green, Purple, Red, Yellow.

EDWAL FILM CLEANER ..... 4 oz. bottle 45c; Gal. bottle 4.20

EDWAL *Color* FILM CLEANER ... 4 oz. bottle 45c; Gal. bottle 4.20

EDWAL FERROTYPE POLISH .... 4 oz. bottle 40c; Gal. bottle 4.75

EDWAL HYPO-CHEK (225 Tests) Shaker-top bottle ..... .40

EDWAL KWIK-WET (Treats 85 pints solution) Shaker-top bot. .45

EDWAL ORTHAZITE .....
..... 1 oz. 95c; 4 oz. $3.50; 1 lb. $12.50; 5 lbs. 50.00

EDWAL PHOTO-CHEM KIT (7 Edwal items) 2.95

EDWAL THERMO-SALT (Pound treats 18 pints) ..... 1 lb. .45

EDWAL SHORTSTOP (Powder). Makes 10 pints ..... .35

EDWAL SIGNAL SHORTSTOP (Makes 32 pts.) ..... Pint .55

Edwal Photo-Pure Chemicals

Edwal developing agents are packed in amber screw-cap bottles. The alkalis and Fine Grain Sulphite are packed in cans.

	1 oz.	4 oz.	1-lb.
AMIDOL (Diaminophenol Dihydrochloride)	$0.65	$2.20	$7.20
CATECHOL (Pyrocatechin C.P.)	.60	1.80	6.20
C.H.Q. (Chlorhydroquinone)	.65	2.20	7.20
DIAMINE-P (Pure Paraphenylenediamine)	.50	1.35	4.50
GRADOL (A Para-Aminophenol Derivative)	.50	1.50	4.50
METOL (Monomethyl Para-Aminophenol Sulphate)	.50	1.35	4.50
MONAZOL (Pure photo glycin)	.60	1.80	6.20
ORTHAMINE (Orthophenylenediamine)	.65	2.20	7.20
POTASSIUM CARBONATE (Anhydrous)			.50
FINE GRAIN SULPHITE (pH controlled)			.35
EDWAL T.S.P. (Trisodium Phosphate Monohydrate)			.55
THIAMATE (3-minute fixing agent)		6 oz. 50c; 1½ lb. $1.10	

Books

MODERN DEVELOPING METHODS—140 pages $0.65

ALL PRICES ARE FOR U. S. AND ARE F.O.B. CHICAGO

(U. S. measures used throughout.)

March 1, 1947

Prices subject to change without notice.

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